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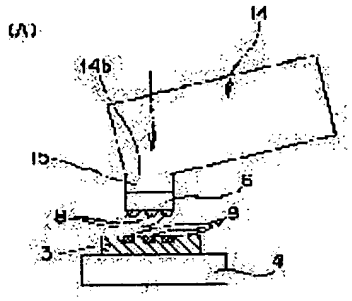
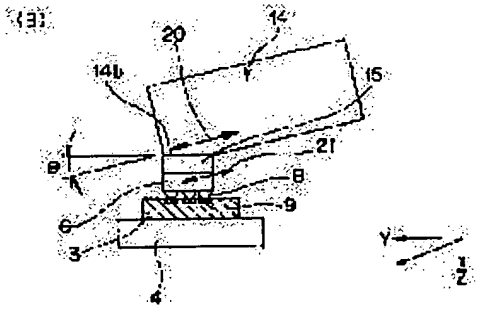
(54) METHOD AND DEVICE FOR ULTRASONIC BONDING

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a method and device for ultrasonic bonding for flip chip mounting by which sufficient bonding strength is obtained and stable bonding can be performed between electronic parts and a substrate.

SOLUTION: A semiconductor chip 6 is bonded to the substrate 3 from the oblique direction (5° to 35° direction) with respect to the horizontal direction perpendicular to the vertical direction by applying ultrasonic vibrations to the chip 6. Consequently, the IC chip 6 makes the same vibrating action as that of a semiconductor chip holding member 15 and the ultrasonic vibrations are stably transmitted to the chip 6. Therefore, the bonding quality between the IC chip 6 and bonded substrate 3 can be improved, because the sufficient bonding strength is obtained between the chip 6 and the substrate 3.





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CLAIMS

[Claim(s)]
[Claim 1] The ultrasonic-jointing approach characterized by to join the above-mentioned bump of the above-mentioned semiconductor chip to the above-mentioned electrode of the above-mentioned substrate, giving supersonic vibration in the direction of slant to the longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip to the above-mentioned semiconductor chip when carrying out flip chip mounting of the semiconductor chip (6) on a substrate (3) carrying out alignment to the bump (8) on the pad (6a) of the above-mentioned semiconductor chip, and the electrode (9) of the above-mentioned substrate, and pressurizing after that.
[Claim 2] The ultrasonic-jointing approach according to claim 1 that whenever [tilt-angle / which gives the above-mentioned supersonic vibration in the direction of slant to the longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip to the above-mentioned semiconductor chip] (theta) is five - 35 degrees.
[Claim 3] The substrate to which the above-mentioned semiconductor chip was joined by the ultrasonic-jointing approach according to claim 1 or 2.
[Claim 4] In the ultrasonic-jointing equipment which gives pressurization and supersonic vibration to a semiconductor chip (6), and joins the above-mentioned semiconductor chip to a substrate (3) The semiconductor chip attachment component which holds the plane of composition of the above-mentioned semiconductor chip, maintaining abbreviation parallel to the plane of composition of the above-mentioned substrate (15), The ultrasonic horn which gives the above-mentioned supersonic vibration to the above-mentioned semiconductor chip held at the above-mentioned semiconductor chip attachment component in the direction of slant to the longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip (14), Ultrasonic-jointing equipment characterized by having the pressurizer (11) which holds the trembler (13) which gives the above-mentioned supersonic vibration to the above-mentioned ultrasonic horn, and the above-mentioned ultrasonic horn, and gives welding pressure to the above-mentioned semiconductor chip to the above-mentioned substrate through the above-mentioned semiconductor chip attachment component.
[Claim 5] Ultrasonic-jointing equipment according to claim 4 whenever [tilt-angle / of the above-mentioned supersonic vibration of the above-mentioned ultrasonic horn which gives the above-mentioned supersonic vibration in the direction of slant for the above-mentioned semiconductor chip attachment component to the longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip to the above-mentioned semiconductor chip / whose] (theta) is five - 35 degrees.
[Claim 6] The ultrasonic-jointing equipment according to claim 4 which fixes the above-mentioned semiconductor chip attachment component at the tip of the above-mentioned ultrasonic horn dismountable with the nut (251) which inserts the attachment shank (1510) which prepared the hole (14c) which extends in the direction which intersects perpendicularly at the tip of the above-mentioned ultrasonic horn to the plane of composition of the above-mentioned substrate, and was prepared in the hole at the above-mentioned semiconductor chip attachment component, prepares **** (1511) in the

attachment shank, and is thrust into the **** and this ****.
[Claim 7] The hole (14c) which extends in the direction which intersects perpendicularly at the above-mentioned tip of an ultrasonic horn to the plane of composition of the above-mentioned substrate is prepared. The attachment shank (152) prepared in the hole at the above-mentioned semiconductor chip attachment component is inserted. Ultrasonic-jointing equipment according to claim 4 which fixes the above-mentioned semiconductor chip attachment component at the tip of the above-mentioned ultrasonic horn dismountable by the mounting screw (26) which prepares the tapped hole (14e) which extends at the tip of the above-mentioned ultrasonic horn so that it may intersect perpendicularly with the attachment shank, and is thrust into the above-mentioned tapped hole and this tapped hole.
[Claim 8] Ultrasonic-jointing equipment according to claim 4 which screws in the screw thread (1531) of the attachment shank (153) which prepared the perpendicular tapped hole (14d) at the tip of the above-mentioned ultrasonic horn to the above-mentioned plane of composition of the above-mentioned substrate, and was prepared in the tapped hole at the above-mentioned semiconductor chip attachment component, and fixes the above-mentioned semiconductor chip attachment component at the tip of the above-mentioned ultrasonic horn dismountable.
[Claim 9] The ultrasonic-jointing equipment according to claim 4 which it had further in the flexurally oscillating section (141) which is prepared along the vertical direction at the tip of the above-mentioned ultrasonic horn, and arranges the above-mentioned semiconductor chip attachment component at the edge by the side of the above-mentioned substrate, and transmits the above-mentioned supersonic vibration while giving the above-mentioned supersonic vibration to the above-mentioned semiconductor chip in the direction of slant to the above-mentioned longitudinal direction where the above-mentioned ultrasonic horn is along the above-mentioned plane of composition of the above-mentioned semiconductor chip, and intersects perpendicularly with the vertical direction.
[Claim 10] While giving the above-mentioned supersonic vibration to the above-mentioned semiconductor chip in the direction of slant to the above-mentioned longitudinal direction where the above-mentioned ultrasonic horn is along the above-mentioned plane of composition of the above-mentioned semiconductor chip, and intersects perpendicularly with the vertical direction The above-mentioned ultrasonic horn is held in the knot section equivalent to two knots of the longitudinal oscillation of the above-mentioned supersonic vibration. It is prepared in along the vertical direction at the part equivalent to the antinode of vibration between the knots of the longitudinal oscillation of the above-mentioned supersonic vibration of the above-mentioned ultrasonic horn. And ultrasonic-jointing equipment according to claim 4 further equipped with the flexurally oscillating section (141) which arranges the above-mentioned semiconductor chip attachment component at the edge by the side of the above-mentioned substrate, and transmits the above-mentioned supersonic vibration to it.
[Claim 11] The above-mentioned ultrasonic horn is ultrasonic-jointing equipment according to claim 10 which held the attachment section (144,145) which pulled out the rib (142,143) once from the knot section equivalent to two knots of the longitudinal oscillation of the above-mentioned supersonic vibration of the above-mentioned ultrasonic horn, and was bent at the right angle to the above-mentioned rib to the above-mentioned pressurizer (11).
[Claim 12] In the knot section in which the above-mentioned ultrasonic horn is equivalent to two knots of the longitudinal oscillation of the above-mentioned supersonic vibration of the above-mentioned ultrasonic horn A rib (1431) is pulled out whenever [-] in a longitudinal direction from the both sides of the ultrasonic horn 14, respectively. Bend at a right angle in the direction of longitudinal oscillation from the above-mentioned rib, and the 1st bending section (1432) is formed. Bend at a right angle further from the above-mentioned 1st bending section in the opposite direction, and the 2nd bending section (1433) is formed. Ultrasonic-jointing equipment according to claim 11 which held the attachment section (144,145) which formed the rib (142,143) in this 2nd bending section, and was bent at the right angle to this rib to the above-mentioned pressurizer (11).
[Claim 13] While giving the above-mentioned supersonic vibration to the above-mentioned semiconductor chip in the direction of slant to the above-mentioned longitudinal direction where the above-mentioned ultrasonic horn is along the above-mentioned plane of composition of the above-

mentioned semiconductor chip, and intersects perpendicularly with the vertical direction Prepare at the tip of the above-mentioned ultrasonic horn along the vertical direction, and it has the flexurally oscillating section (141) which arranges the above-mentioned semiconductor chip attachment component at the edge by the side of the above-mentioned substrate, and transmits the above-mentioned supersonic vibration to it. The attachment shank (152) which prepared the perpendicular hole (141b) to the above-mentioned plane of composition of the above-mentioned substrate, and was prepared in the hole at the above-mentioned semiconductor chip attachment component is inserted. A tapped hole (141e) is perpendicularly established in the above-mentioned flexurally oscillating section to the shaft orientations of the attachment shank. Ultrasonic-jointing equipment according to claim 9 or 10 which fixed the above-mentioned semiconductor chip attachment component to the above-mentioned flexurally oscillating section dismountable by the mounting screw (26) thrust into the above-mentioned tapped hole and the above-mentioned tapped hole.

[Claim 14] While giving the above-mentioned supersonic vibration to the above-mentioned semiconductor chip in the direction of slant to the above-mentioned longitudinal direction where the above-mentioned ultrasonic horn is along the above-mentioned plane of composition of the above-mentioned semiconductor chip, and intersects perpendicularly with the vertical direction In the flexurally oscillating section (141) which prepares in along the vertical direction at the tip of the above-mentioned ultrasonic horn, and arranges the above-mentioned semiconductor chip attachment component at the edge by the side of the above-mentioned substrate, and transmits the above-mentioned supersonic vibration The attachment shank (152) which prepared the rate bundle hole (146) and was prepared in the rate bundle hole at the above-mentioned semiconductor chip attachment component is inserted. A tapped hole (146a) is established in the above-mentioned rate bundle hole at right angles to the shaft orientations of the attachment shank. Ultrasonic-jointing equipment according to claim 9 or 10 which fixes the above-mentioned semiconductor chip attachment component to the above-mentioned flexurally oscillating section for the above-mentioned semiconductor chip attachment component thrust into the above-mentioned tapped hole and the above-mentioned tapped hole dismountable by the mounting screw (27).

[Claim 15] While giving the above-mentioned supersonic vibration to the above-mentioned semiconductor chip in the direction of slant to the above-mentioned longitudinal direction where the above-mentioned ultrasonic horn is along the above-mentioned plane of composition of the above-mentioned semiconductor chip, and intersects perpendicularly with the vertical direction The flexurally oscillating section (141) which prepares at the tip of the above-mentioned ultrasonic horn along the vertical direction, and arranges the above-mentioned semiconductor chip attachment component at the edge by the side of the above-mentioned substrate, and transmits the above-mentioned supersonic vibration While preparing a perpendicular hole (1411) to the above-mentioned plane of composition of the above-mentioned substrate and preparing a 20 degrees - 40 degrees roofing inclined plane (1412) at the tip, the above-mentioned semiconductor chip attachment component Prepare a slit (1543) in the core at the tip, and a somewhat larger hollow (1541) than the above-mentioned semiconductor chip of a configuration of holding the above-mentioned semiconductor chip from a longitudinal direction is prepared. The inclined plane (1542) of whenever [same tilt-angle] is prepared. whenever [tilt-angle / of the roofing inclined plane established in the upper part at the above-mentioned flexurally oscillating section], and a profile -- An attachment shank (1544) is constituted on it. The above-mentioned flexurally oscillating section and the above-mentioned semiconductor chip attachment component If pressurized with the above-mentioned pressurizer, the above-mentioned inclined planes prepared in the above-mentioned semiconductor chip attachment component will contact the above-mentioned flexurally oscillating section for each other. And it is constituted so that the inside of the above-mentioned hollow of the above-mentioned semiconductor chip attachment component may put the above-mentioned semiconductor chip, when the above-mentioned semiconductor chip attachment component bends so that the above-mentioned slit may be narrowed. The above-mentioned semiconductor chip attachment component to the notch (1545) prepared in the attachment shank The ball plunger (28) perpendicularly prepared in the above-mentioned flexurally oscillating section to the

shaft orientations of the attachment shank (1544) is pressed. Ultrasonic-jointing equipment according to claim 9 or 10 constituted so that the above-mentioned semiconductor chip attachment component can pull up upward in one with the above-mentioned flexurally oscillating section.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention gives pressurization and supersonic vibration to semiconductor chips, such as electronic parts, for example, IC chip etc., and relates to the ultrasonic-jointing approach for flip chip mounting which joins the above-mentioned semiconductor chip to a circuit organizer, for example, a substrate, and its equipment.
[0002] Here, a circuit organizer means objects with which the circuit is formed, such as the circuit boards, such as the circuit boards, such as a resin substrate, a paper-phenol substrate, a ceramic substrate, a glass epoxy (GARAEPO) substrate, and a film substrate, a monolayer substrate, or a multilayer substrate, components, a case, or a frame.
[0003]
[Description of the Prior Art] Conventional flip chip mounting equipment 130 is shown in drawing 24 . The substrate (henceforth a "junction substrate") 103 to which it should be carried in to by the transport device 102, and IC chip should be joined is heated being controlled by the heating control unit 107 connected to the heating stage 104 to supply the heating stage 104, and to hold fix a substrate 103 to the above-mentioned heating stage 104, and to be shown in drawing 25 . Subsequently, sequential delivery of the one IC chip 106 picked out from the wafer sheet 105 is carried out to the semiconductor chip attachment component 115 with which the junction pressurizer 101 is equipped.
[0004] As shown in drawing 24 - drawing 26 , adsorption immobilization is carried out at the semiconductor chip attachment component 115, and this IC chip 106 is positioned through recognition actuation in the predetermined location of the junction substrate 103. Subsequently, when the IC chip 106 can give pressurization and supersonic vibration to the junction substrate 103 with the junction pressurizer 101, metal junction of the bump 108 of the IC chip 106 and the electrode 109 of the junction substrate 103 is carried out. The above-mentioned junction pressurizer 101 has the voice coil motor 111 as a pressurizer of the IC chip 106 and the junction substrate 103 which performs pressurization for junction while moving the above-mentioned semiconductor chip attachment component 115 in the thickness direction of the IC chip 106 or the junction substrate 103, a bracket 112 is formed in a part for the point of driving shaft 111a of the above-mentioned voice coil motor 111, and the ultrasonic horn 114 is attached in the above-mentioned bracket 112. The above-mentioned semiconductor chip attachment component 115 is attached in the end section of the ultrasonic horn 114, and vibrator 113 is attached in the other end. An ultrasonic wave oscillator 117 is connected to the above-mentioned vibrator 113, and vibrator 113 is made to generate supersonic vibration. Moreover, motion control of the above-mentioned voice coil motor 111 is carried out with the junction pressurization control unit 116.
[0005] In accordance with the shaft orientations, interruption is prepared in the above-mentioned ultrasonic horn 114, and as shown in drawing 25 , the semiconductor chip attachment component 115 is ****(ed) by the shaft orientations of the semiconductor chip attachment component 115 by the above-mentioned interruption from the rectangular cross. In addition, as mentioned above, although the piping 124 for suction is connected to the semiconductor chip attachment component 115 in order that the

semiconductor chip attachment component 115 may adsorb the IC chip 106, the above-mentioned piping 124 for suction is not supported by the bracket 112. Moreover, the location of **** which hits the knot section 142 of the longitudinal oscillation of the supersonic vibration which the above-mentioned trembler 113 emits is broken by the bracket 112 with a bolt 123, bundle conclusion is carried out, and the ultrasonic horn 104 is pressurized by the voice coil motor 111 currently installed in the upper part of the above-mentioned bracket 112 as mentioned above.

[0006]

[Problem(s) to be Solved by the Invention] However, with the above conventional structures, since the tip of the semiconductor chip attachment component 115 vibrates almost horizontally by flexural oscillation, slipping occurs, and skillful ****** of the vibration is not carried out to the IC chip 106, but it has become the cause which sufficient bonding strength of the IC chip 106 and the junction substrate 103 is no longer obtained, and induces poor junction opening. Moreover, there is a problem that a blemish and a crack 100 which were struck as shown in the IC chip 106 by the slipping at (A) of drawing 2727 by the semiconductor chip attachment component 115 and (B) occur.

[0007] Furthermore, as mentioned above, with the conventional structure, when the welding pressure by the voice coil motor 111 becomes large, the moment from the semiconductor chip attachment component 115 works in the knot section 142 of the ultrasonic horn 114, it inclines to the longitudinal direction in which the vertical direction and the ultrasonic horn 114 cross at right angles, the parallelism between the apical surface of the semiconductor chip attachment component 115 and the plane of composition of the junction substrate 103 collapses, and there is a problem that skillful ****** of the vibration is not carried out to the IC chip 106. Moreover, distortion occurs in the knot section 142 of the ultrasonic horn 114, the resonance state of the ultrasonic horn 114 collapses, and the amplitude to the IC chip 106 is not stabilized, but it has become the cause which sufficient bonding strength of the IC chip 106 and the junction substrate 103 is no longer obtained, and induces poor junction opening.

[0008] With the conventional structure, interruption is prepared in the ultrasonic horn 114 in accordance with the shaft orientations. Moreover, the semiconductor chip attachment component 115 Since the shaft orientations of the semiconductor chip attachment component 115 **** by the above-mentioned interruption from the rectangular cross, Flexural oscillation of the semiconductor chip attachment component 115 becomes unstable by change of ****** by interruption. The amplitude to the IC chip 106 is not stabilized, but it has become the cause which sufficient bonding strength of the IC chip 106 and the junction substrate 103 is no longer obtained, and induces poor junction opening.

[0009] Furthermore, the miniaturization of an electron device is increasingly called for with small-and-light-izing of electronic equipment, mounting technology invites a turning point to a flip chip method from a wiring method, and it has been a big technical problem that a multi-pin IC chip is also joinable on a large scale in recent years again.

[0010] Under such conditions, it is clear that above-mentioned poor junction opening increases rapidly while it has been the conventional configuration, since increase of junction welding pressure and ultrasonic power is needed.

[0011] The purpose of this invention is offering the ultrasonic-jointing approach for flip chip mounting it having been made in order to solve such a trouble, and sufficient bonding strength of electronic parts and a substrate being obtained, and stable junction being performed, and its equipment.

[0012]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention is constituted as follows.

[0013] The ultrasonic-jointing approach characterized by to join the above-mentioned bump on the above-mentioned pad of the above-mentioned semiconductor chip to the above-mentioned electrode of the above-mentioned substrate offers giving supersonic vibration in the direction of slant to the above-mentioned semiconductor chip to the longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip, when carrying out flip chip mounting of the semiconductor chip on a substrate, if this invention is caused like the 1st voice carrying out alignment to the bump on the pad of the above-mentioned semiconductor chip, and the electrode of the above-

mentioned substrate, and pressurizing after that.
[0014] If this invention is caused like the 2nd voice, the 1st mode whenever [tilt-angle / which gives the above-mentioned supersonic vibration in the direction of slant to the longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip to the above-mentioned semiconductor chip / whose] is five - 35 degrees will be provided with the ultrasonic-jointing approach of a publication.
[0015] If this invention is caused like the 3rd voice, the substrate by which the above-mentioned semiconductor chip was joined to the mode of the 1st or 2 by the ultrasonic-jointing approach of a publication will be offered.
[0016] In the ultrasonic-jointing equipment which will give pressurization and supersonic vibration to a semiconductor chip, and will join the above-mentioned semiconductor chip to a substrate if this invention is caused like the 4th voice The semiconductor chip attachment component which holds the plane of composition of the above-mentioned semiconductor chip, maintaining abbreviation parallel to the plane of composition of the above-mentioned substrate, The ultrasonic horn which gives the above-mentioned supersonic vibration to the above-mentioned semiconductor chip held at the above-mentioned semiconductor chip attachment component in the direction of slant to the longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip, The ultrasonic-jointing equipment characterized by having the pressurizer which holds the trembler which gives the above-mentioned supersonic vibration to the above-mentioned ultrasonic horn, and the above-mentioned ultrasonic horn, and gives welding pressure to the above-mentioned semiconductor chip to the above-mentioned substrate through the above-mentioned semiconductor chip attachment component is offered.
[0017] If this invention is caused like the 5th voice, the 4th mode whenever [tilt-angle / of the above-mentioned supersonic vibration of the above-mentioned ultrasonic horn which gives the above-mentioned supersonic vibration in the direction of slant for the above-mentioned semiconductor chip attachment component to the longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip to the above-mentioned semiconductor chip / whose] is five - 35 degrees will be provided with the ultrasonic-jointing equipment of a publication.
[0018] The attachment shank which prepared the hole which extends in the direction which intersects perpendicularly at the tip of the above-mentioned ultrasonic horn to the plane of composition of the above-mentioned substrate, and prepared in the hole at the above-mentioned semiconductor chip attachment component when this invention was caused like the 6th voice inserts, **** prepares in the attachment shank, and the 4th mode which fixes the above-mentioned semiconductor chip attachment component dismountable at the tip of the above-mentioned ultrasonic horn with the nut thrust into the **** and this **** provides with the ultrasonic-jointing equipment of a publication.
[0019] If this invention is caused like the 7th voice, the hole which extends in the direction which intersects perpendicularly at the above-mentioned tip of an ultrasonic horn to the plane of composition of the above-mentioned substrate will be prepared. Insert the attachment shank prepared in the hole at the above-mentioned semiconductor chip attachment component, and the tapped hole which extends at the tip of the above-mentioned ultrasonic horn so that it may intersect perpendicularly with the attachment shank is prepared. The 4th mode which fixes the above-mentioned semiconductor chip attachment component at the tip of the above-mentioned ultrasonic horn dismountable by the mounting screw thrust into the above-mentioned tapped hole and this tapped hole is provided with the ultrasonic-jointing equipment of a publication.
[0020] If this invention is caused like the 8th voice, **** of an attachment shank which prepared the perpendicular tapped hole at the tip of the above-mentioned ultrasonic horn to the above-mentioned plane of composition of the above-mentioned substrate, and was prepared in the tapped hole at the above-mentioned semiconductor chip attachment component will be thrust, and the 4th mode which fixes the above-mentioned semiconductor chip attachment component at the tip of the above-mentioned ultrasonic horn dismountable will be provided with the ultrasonic-jointing equipment of a publication.
[0021] If this invention is caused like the 9th voice, while giving the above-mentioned supersonic

vibration to the above-mentioned semiconductor chip in the direction of slant to the above-mentioned longitudinal direction where the above-mentioned ultrasonic horn is along the above-mentioned plane of composition of the above-mentioned semiconductor chip, and intersects perpendicularly with the vertical direction The 4th mode further equipped with the flexurally oscillating section which is prepared at the tip of the above-mentioned ultrasonic horn along the vertical direction, and arranges the above-mentioned semiconductor chip attachment component at the edge by the side of the above-mentioned substrate, and transmits the above-mentioned supersonic vibration is provided with the ultrasonic-jointing equipment of a publication.

[0022] If this invention is caused like the 10th voice, while giving the above-mentioned supersonic vibration to the above-mentioned semiconductor chip in the direction of slant to the above-mentioned longitudinal direction where the above-mentioned ultrasonic horn is along the above-mentioned plane of composition of the above-mentioned semiconductor chip, and intersects perpendicularly with the vertical direction The above-mentioned ultrasonic horn is held in the knot section equivalent to two knots of the longitudinal oscillation of the above-mentioned supersonic vibration. It is prepared in along the vertical direction at the part equivalent to the antinode of vibration between the knots of the longitudinal oscillation of the above-mentioned supersonic vibration of the above-mentioned ultrasonic horn. And the 4th mode further equipped with the flexurally oscillating section which arranges the above-mentioned semiconductor chip attachment component at the edge by the side of the above-mentioned substrate, and transmits the above-mentioned supersonic vibration to it is provided with the ultrasonic-jointing equipment of a publication.

[0023] If this invention is caused like the 11th voice, the above-mentioned ultrasonic horn will pull out a rib once from the knot section equivalent to two knots of the longitudinal oscillation of the above-mentioned supersonic vibration of the above-mentioned ultrasonic horn, and will provide with the ultrasonic-jointing equipment of a publication the 10th mode which held the attachment section bent at the right angle to the above-mentioned rib to the above-mentioned pressurizer.

[0024] If this invention is caused like the 12th voice, the above-mentioned ultrasonic horn In the knot section equivalent to two knots of the longitudinal oscillation of the above-mentioned supersonic vibration of the above-mentioned ultrasonic horn A rib is pulled out whenever [-] in a longitudinal direction from the both sides of the ultrasonic horn 14, respectively. Bend at a right angle in the direction of longitudinal oscillation from the above-mentioned rib, and the 1st bending section is formed. It bends at a right angle further from the above-mentioned 1st bending section in that opposite direction, the 2nd bending section is formed, a rib is formed in this 2nd bending section, and the 11th mode which held the attachment section bent at the right angle to this rib to the above-mentioned pressurizer is provided with the ultrasonic-jointing equipment of a publication.

[0025] If this invention is caused like the 13th voice, while giving the above-mentioned supersonic vibration to the above-mentioned semiconductor chip in the direction of slant to the above-mentioned longitudinal direction where the above-mentioned ultrasonic horn is along the above-mentioned plane of composition of the above-mentioned semiconductor chip, and intersects perpendicularly with the vertical direction Prepare at the tip of the above-mentioned ultrasonic horn along the vertical direction, and it has the flexurally oscillating section which arranges the above-mentioned semiconductor chip attachment component at the edge by the side of the above-mentioned substrate, and transmits the above-mentioned supersonic vibration to it. The attachment shank which prepared the perpendicular hole to the above-mentioned plane of composition of the above-mentioned substrate, and was prepared in the hole at the above-mentioned semiconductor chip attachment component is inserted. A tapped hole is perpendicularly established in the above-mentioned flexurally oscillating section to the shaft orientations of the attachment shank, and the mode of the 9th or 10 which fixed the above-mentioned semiconductor chip attachment component to the above-mentioned flexurally oscillating section dismountable by the mounting screw thrust into the above-mentioned tapped hole and the above-mentioned tapped hole is provided with the ultrasonic-jointing equipment of a publication.

[0026] If this invention is caused like the 14th voice, while giving the above-mentioned supersonic vibration to the above-mentioned semiconductor chip in the direction of slant to the above-mentioned

longitudinal direction where the above-mentioned ultrasonic horn is along the above-mentioned plane of composition of the above-mentioned semiconductor chip, and intersects perpendicularly with the vertical direction In the flexurally oscillating section which prepares in along the vertical direction at the tip of the above-mentioned ultrasonic horn, and arranges the above-mentioned semiconductor chip attachment component at the edge by the side of the above-mentioned substrate, and transmits the above-mentioned supersonic vibration The attachment shank which prepared the rate bundle hole and was prepared in the rate bundle hole at the above-mentioned semiconductor chip attachment component is inserted. A tapped hole is established in the above-mentioned rate bundle hole at right angles to the shaft orientations of the attachment shank. The mode of the 9th or 10 which fixes the above-mentioned semiconductor chip attachment component to the above-mentioned flexurally oscillating section for the above-mentioned semiconductor chip attachment component thrust into the above-mentioned tapped hole and the above-mentioned tapped hole dismountable by the mounting screw is provided with the ultrasonic-jointing equipment of a publication.

[0027] If this invention is caused like the 15th voice, while giving the above-mentioned supersonic vibration to the above-mentioned semiconductor chip in the direction of slant to the above-mentioned longitudinal direction where the above-mentioned ultrasonic horn is along the above-mentioned plane of composition of the above-mentioned semiconductor chip, and intersects perpendicularly with the vertical direction The flexurally oscillating section which prepares at the tip of the above-mentioned ultrasonic horn along the vertical direction, and arranges the above-mentioned semiconductor chip attachment component at the edge by the side of the above-mentioned substrate, and transmits the above-mentioned supersonic vibration While preparing a perpendicular hole to the above-mentioned plane of composition of the above-mentioned substrate and preparing a 20 degrees - 40 degrees roofing inclined plane at the tip, the above-mentioned semiconductor chip attachment component Prepare a slit in the core at the tip and a somewhat larger hollow than the above-mentioned semiconductor chip of a configuration of holding the above-mentioned semiconductor chip from a longitudinal direction is prepared. whenever [tilt-angle / of the roofing inclined plane established in the upper part at the above-mentioned flexurally oscillating section], and a profile -- the inclined plane of whenever [same tilt-angle] being prepared, and an attachment shank being constituted on it, and the above-mentioned flexurally oscillating section and the above-mentioned semiconductor chip attachment component, if pressurized with the above-mentioned pressurizer The above-mentioned inclined planes prepared in the above-mentioned semiconductor chip attachment component contact the above-mentioned flexurally oscillating section for each other. And it is constituted so that the inside of the above-mentioned hollow of the above-mentioned semiconductor chip attachment component may put the above-mentioned semiconductor chip, when the above-mentioned semiconductor chip attachment component bends so that the above-mentioned slit may be narrowed. The ball plunger perpendicularly prepared in the above-mentioned flexurally oscillating section to the shaft orientations of the attachment shank is pressed against the notch which prepared the above-mentioned semiconductor chip attachment component in the attachment shank. The mode of the 9th or 10 constituted so that the above-mentioned semiconductor chip attachment component can pull up upward in one with the above-mentioned flexurally oscillating section is provided with the ultrasonic-jointing equipment of a publication.

[0028]

[Embodiment of the Invention] Below, the gestalt of operation concerning this invention is explained at a detail based on a drawing.

[0029] (The 1st operation gestalt) The ultrasonic-jointing equipment for flip chip mounting which can enforce the ultrasonic-jointing approach which starts the 1st operation gestalt of this invention at drawing 1 - drawing 3 and drawing 11 - drawing 12 is shown.

[0030] The whole flip chip mounting equipment 30 equipped with the above-mentioned ultrasonic-jointing equipment 1 for flip chip mounting is shown in drawing 11 . The substrate (henceforth a "junction substrate") 3 to which it should be carried in to in transport-device 2A, and the IC chip 6 as an example of a semiconductor chip should be joined is heated being controlled by the heating control unit 7 connected to the heating stage 4 to supply the heating stage 4, and to hold fix a substrate 3 to the

above-mentioned heating stage 4, and to be shown in drawing 12 . Subsequently, sequential delivery of the one IC chip 6 which adsorbed by IC chip extractor 1A, and was picked out from the wafer sheet 5 is carried out at the semiconductor chip attachment component 15 with which the junction pressurizer 1 is equipped. Subsequently, as shown in drawing 11 - drawing 12 , adsorption immobilization is carried out at the semiconductor chip attachment component 5, and this IC chip 6 is positioned through recognition actuation in the predetermined location of the junction substrate 3. Subsequently, when the IC chip 6 can give pressurization and supersonic vibration to the junction substrate 3 with the above-mentioned ultrasonic-jointing equipment 1 for flip chip mounting, metal junction of each bump 8 and each electrode 9 of the junction substrate 3 which were beforehand formed on pad 6a of the IC chip 6 is carried out. The above-mentioned junction pressurizer 1 performs pressurization for junction to the IC chip 6 and the junction substrate 3 while moving the above-mentioned semiconductor chip attachment component 5 in the thickness direction of the IC chip 6 or the junction substrate 3. Subsequently, the junction substrate 3 to which the IC chip 6 was joined is taken out in transport-device 2B.

[0031] The above-mentioned ultrasonic-jointing equipment 1 for flip chip mounting The substrate to which pressurization and supersonic vibration are given to the IC chip 6, and the IC chip 6 should be joined (it is hereafter called a "junction substrate".) The semiconductor chip attachment component 15 which is ultrasonic-jointing equipment which joins the above-mentioned IC chip 6 to 3 directly, and holds the plane of composition of the above-mentioned IC chip 6, maintaining abbreviation parallel to the plane of composition of the above-mentioned substrate 3, As opposed to the longitudinal direction which is a longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip, for example, intersects perpendicularly with the vertical direction at the above-mentioned IC chip 6 held at the above-mentioned semiconductor chip attachment component 15 The ultrasonic horn 14 which gives the above-mentioned supersonic vibration in the direction of slant, and the vibrator 13 which gives the above-mentioned supersonic vibration to the above-mentioned ultrasonic horn 14, It has the voice coil motor 11 as an example of a pressurizer which holds the above-mentioned ultrasonic horn 14, and gives the welding pressure for junction to the above-mentioned IC chip 6 to the above-mentioned substrate 3 through the above-mentioned semiconductor chip attachment component 15.

[0032] The above-mentioned voice coil motor 11 generates welding pressure 111, and as shown in drawing 12 , motion control is carried out with the junction pressurization control unit 16. In drawing 12 , in the lower limit part of driving shaft 11a of the above-mentioned voice coil motor 11, the profile inverse L-shaped bracket 12 is formed, and the above-mentioned ultrasonic horn 14 is attached in the above-mentioned bracket 12 at it with whenever [tilt-angle / toward which 5 degrees - 35 degrees of the longitudinal shaft orientations inclined to the longitudinal direction which intersects perpendicularly with the vertical direction] so that it may mention later. If whenever [above-mentioned tilt-angle] is less than 5 degrees, the reason for making whenever [above-mentioned tilt-angle] into such range is because a crack may occur for IC chip, when a crack may occur for IC chip and whenever [above-mentioned tilt-angle] exceeds 35 degrees. Whenever [above-mentioned tilt-angle] is 15 degrees preferably from a viewpoint of IC chip bonding strength.

[0033] The relation between whenever [tilt-angle / of this ultrasonic horn 14], and junction quality and ultrasonic characteristics is shown in Table 1.

[0034]

[Table 1]

超音波ホーン / 傾斜角度 / 項　目	0°	5°	10°	15°	20°	30°	45°
ICチップ接合強度	○	○	◎	◎	◎	○	−
ICチップのクラック	×	△	◎	◎	◎	△	−
超音波振動特性	◎	○	○	○	○	△	×
総合評価	△	△	○	◎	○	×	×

[0035] In the above-mentioned table 1, superiority and O show fitness and, as for O in IC chip bonding strength, an ultrasonic oscillation characteristic, and comprehensive evaluation, in **, x usually shows measurement ****, as for bad -. nothing and ** do not measure a crack, and 3% or more of crack incidence rates and - do not measure less than 3% of crack incidence rates, and x at all, but it comes out of O in the crack of IC chip.
[0036] as evaluation conditions, each bump consists of Au and uses ** which has 50 bumps per 50 bumps / IC chip formed of stud bump bonding, i.e., one IC chip. The quality of the material of IC chip is Si (silicon), and the substrate quality of the material is a ceramic, and it considers as Au electrode. Moreover, welding pressure is 40Ns at the time of junction, and an ultrasonic frequency is set to 63kHz.
[0037] It turns out that the above-mentioned include-angle range is more desirable than the result of this table.
[0038] On the other hand, the above-mentioned semiconductor chip attachment component 15 is attached in the end section of the longitudinal shaft orientations of the above-mentioned ultrasonic horn 14, and the above-mentioned vibrator 13 is attached in the other end of the longitudinal shaft orientations. As shown in drawing 12 , an ultrasonic wave oscillator 17 is connected to the above-mentioned vibrator 13, and he is trying to make vibrator 13 generate supersonic vibration with an ultrasonic wave oscillator 17.
[0039] Moreover, the ultrasonic horn 14 is divided into a bracket 12 by the location of **** which hits the knot section of the longitudinal oscillation of the supersonic vibration which the above-mentioned trembler 13 emits with a bolt 25, and bundle conclusion is carried out in it. Namely, it forms in the ultrasonic horn 4 so that the mounting flanges 14a and 14a of the pair prolonged on both sides may be jutted out over the location of **** which hits the knot section of the longitudinal oscillation of the supersonic vibration which the above-mentioned vibrator 13 of the ultrasonic horn 4 emits, as shown in drawing 4 . By concluding each of this mounting flange 14a with a bolt 25, respectively to tie-down plate 12a divided into the two forks of a bracket 12 It is attached in the bracket 12 with whenever [tilt-angle / toward which 5 degrees - 35 degrees of longitudinal shaft orientations of the ultrasonic horn 4 inclined to the longitudinal direction which intersects perpendicularly with the vertical direction].
[0040] The above-mentioned semiconductor chip attachment component 15 is the following, and is made and attached in the end section of the longitudinal shaft orientations of the above-mentioned ultrasonic horn 14. Namely, the ultrasonic horn 14 has lower limit side 14b along the longitudinal direction which intersects perpendicularly with the vertical direction at the end section of the longitudinal shaft orientations. As an example of the approach of fixing the above-mentioned semiconductor chip attachment component 15 to this lower limit side 14b As shown in drawing 3 , the above-mentioned semiconductor chip attachment component 15 has the attachment shank 1510 with which **** 1511 was cut. It turns to the upper part from lower limit side 14b of the longitudinal shaft-orientations top Norikazu edge of the ultrasonic horn 14. By making through hole 14c of the ultrasonic horn 14 penetrate the attachment shank 1510 of the above-mentioned semiconductor chip attachment component 15, and thrusting a nut 251 into the screw thread 1511 of the attachment shank 1510 projected from the ultrasonic horn 14 to the upper part Conclusion immobilization of the above-mentioned semiconductor chip attachment component 15 is carried out dismountable at lower limit side 14b of the longitudinal shaft-orientations top Norikazu edge of the ultrasonic horn 14.

[0041] The piping 24 for suction is connected to the through tube of a large number formed in the lower limit side of the semiconductor chip attachment component 15, and the above-mentioned semiconductor chip attachment component 15 enables it to adsorb the IC chip 6 in the lower limit side of the semiconductor chip attachment component 15 by suction actuation which leads the through tube of a large number formed in the lower limit side of the semiconductor chip attachment component 15 in order to adsorb the IC chip 6. The above-mentioned piping 24 for suction is supported by the bracket 12. Thus, as shown in drawing 1 and drawing 2 , although adsorption immobilization of the IC chip 6 is carried out at the semiconductor chip attachment component 15 attracted through the piping 24 for suction as an example, the IC chip 6 may be made to be held by magnetism instead of adsorption to the semiconductor chip attachment component 15. The lower limit side of the above-mentioned semiconductor chip attachment component 15 has the desirable thing with the quality of the material of the IC chip 6 which has good affinity. For example, it is desirable that constitute the above-mentioned lower limit side from SUS (stainless steel) when the quality of the material of the IC chip 6 is silicon, and the quality of the material of the IC chip 6 constitutes the above-mentioned lower limit side from a super-steel ingredient in the case of compound semiconductors, such as gallium-arsenic.
[0042] The junction substrate 3 is fixed by adsorption etc. on the heating stage 4.
[0043] The ultrasonic-jointing approach which used the ultrasonic-jointing equipment for the above-mentioned flip chip mounting for below is explained.
[0044] The adsorption immobilization of the IC chip 6 is carried out through the piping 24 for suction in the lower-limit side of the semiconductor chip attachment component 15, and the IC chip 6 held at the semiconductor chip attachment component 15 is positioned in the location it should join in the junction substrate 3 which was fixed on the heating stage 4 and heated, amending whenever [attitude-angle] based on a recognition result, after the maintenance posture has been recognized by recognition actuation which is not illustrated.
[0045] Subsequently, while moving the IC chip 6 in the thickness direction of the IC chip 6 and the junction substrate 3 to the bottom of control of the junction pressurization control device 16 by the held above-mentioned semiconductor chip attachment component 15 with the above-mentioned ultrasonic-jointing equipment 1 for flip chip mounting, junction pressurization motion control is carried out with a voice coil motor 11 and the junction pressurization control device 16, and pressurization pushing for junction to the IC chip 6 and the junction substrate 3 is performed. a supersonic vibration signal is sent to the vibrator 13 of the ultrasonic horn 14 attached in this, simultaneously the bracket 12 to which the voice coil motor 11 was attached previously from an ultrasonic wave oscillator 17, vibration generated with vibrator 13 is amplified in the ultrasonic horn 14, and supersonic vibration 20 is given to the semiconductor chip attachment component 15 with whenever [tilt-angle / of 5 degrees - 35 degrees] to the longitudinal direction which intersects perpendicularly with the vertical direction. As a result of carrying out the friction transfer of this supersonic vibration 20 through the ultrasonic horn 14 and the semiconductor chip attachment component 15 at the IC chip 6 held at the semiconductor chip attachment component 15, and the IC chip's 6 vibrating on the junction substrate 3 by the supersonic vibration 20 of the ultrasonic horn 14, and the supersonic vibration 21 of the same direction and carrying out metal junction of each bump 8 of the IC chip 6, and each electrode 9 of the junction substrate 3, the IC chip 6 is joined to the junction substrate 3.
[0046] In addition, as the member which adsorbs the IC chip 6 and constitutes the lower limit side of the semiconductor chip attachment component 15 shows the quality of the material and surface roughness of dismountable collet 15a to drawing 8 R> 8, the quality of the material and surface roughness of collet 15a of the semiconductor chip attachment component 15 have a desirable combination to which it is influenced by the quality of the material of the IC chip 6 which is a candidate for junction, and surface roughness, and coefficient of friction becomes high most. For example, if the IC chip 6 is a silicon IC chip, it will be SUS material about collet 15a, and 0.1 micrometers or less, then coefficient of friction will also have high surface roughness, and it will be easy to transmit vibration. In addition, if it compares from the conventional method with little Z vibration the case of the 1st operation gestalt because there is an oscillating component of a Z direction, the effect of the above-mentioned coefficient

of friction will become small.
[0047] According to the above-mentioned 1st operation gestalt, while the tip of the semiconductor chip attachment component 15 pressurizes, in order to transmit supersonic vibration in the direction of slant (direction which inclined 5 degrees - 35 degrees as opposed to the longitudinal direction which intersects perpendicularly with the vertical direction) to the longitudinal direction which intersects perpendicularly with the vertical direction, the IC chip 6 carries out the same oscillating behavior to the semiconductor chip attachment component 15, supersonic vibration is stabilized, and it is transmitted to the IC chip 6 at the IC chip 6. Thereby, sufficient bonding strength of the IC chip 6 and the junction substrate 3 is obtained, and junction dependability improves. The comparison with the former is shown in drawing 5 about this junction dependability. namely, drawing 5 -- the number of the bump 8 in the IC chip 6, and poor junction (in other words, bonding strength is weak) -- comparatively -- ** -- it is drawing showing relation. When the axis of abscissa of drawing 5 joins IC chip by each of the 1st operation gestalt and the conventional ultrasonic-jointing approach, a bump's 8 number shows 10 per IC chip, 30 per IC chip, 50 per IC chip, and 100 cases per IC chip, and an axis of ordinate shows the rate of the poor junction in each case at a percentage.
[0048] Moreover, in order that the IC chip 6 may carry out the same oscillating behavior to the semiconductor chip attachment component 15, there is no damage to the IC chip 6 by the semiconductor chip attachment component 15.
[0049] Moreover, as shown in drawing 6 , supersonic vibration will have the component of the vertical direction, i.e., a Z direction, and in order to join the IC chip 6 to a substrate 3 by the supersonic vibration of the direction of slant to the longitudinal direction which intersects perpendicularly with the vertical direction according to the 1st operation gestalt, as shown in drawing 7 , junction is completed for a short time. In addition, the axis of abscissa of drawing 7 shows the ultrasonic-jointing approach the above-mentioned 1st operation gestalt and for the conventional flip chip mounting, and an axis of ordinate shows a jointing time.
[0050] Moreover, since the semiconductor chip attachment component 15 can be attached in the end section of the longitudinal shaft orientations of the ultrasonic horn 14 by association with a bolt and a nut according to the 1st operation gestalt, The semiconductor chip attachment component 15 from which whenever [champing-angle / of the semiconductor chip attachment component 15 and the attachment shank 1510] differs by loosening association with a bolt and a nut, Or it can exchange for the semiconductor chip attachment component 15 which has the lower limit side which inclined to lower limit side 14b of the ultrasonic horn 14 easily, and whenever [champing-angle / of the semiconductor chip attachment component 15 to the ultrasonic horn 14] can adjust easily.
[0051] According to the 1st operation gestalt, the semiconductor chip attachment component 15 moreover, in the end section of the longitudinal shaft orientations of the ultrasonic horn 14 Since it can attach dismountable by thrusting a nut 251 into the screw thread 1511 of the attachment shank 1510 of the semiconductor chip attachment component 15, Even if it can fix the semiconductor chip attachment component 15 firmly and dismountable and wears out the semiconductor chip attachment component 15 from the front upper part of the ultrasonic horn 14, member exchange can be easily carried out by loosening association with **** 1511 and a nut 251.
[0052] In addition, in drawing 9 , relation with welding-pressure [of the supersonic vibration in the ultrasonic-jointing approach for flip chip mounting of the above-mentioned 1st operation gestalt and the vertical direction] F {=(bump number per IC chip) x0.8N} is shown, and a graph shows the relation between the supersonic vibration in the ultrasonic-jointing approach for flip chip mounting of the above-mentioned 1st operation gestalt, and the welding pressure of the vertical direction to drawing 10 at it. The junction conditions for securing junction height h after junction between the IC chip 6 and a substrate 3 are shown in drawing 10 . In order to obtain the bonding strength higher than drawing 10 as junction conditions, there is balance of proper ultrasonic power and welding pressure, and even if either is too strong and it is too weak, it turns out that the bonding strength obtained becomes weak.
[0053] (The 2nd operation gestalt) The 1st operation gestalt is a different approach and the ultrasonic-jointing approach for flip chip mounting concerning the 2nd operation gestalt of this invention and its

equipment fix the above-mentioned semiconductor chip attachment component 15 to lower limit side 14b of the longitudinal shaft-orientations top Norikazu edge of the ultrasonic horn 14. Namely, as shown in drawing 13 , the above-mentioned semiconductor chip attachment component 15 has the attachment shank 152. It turns to the upper part from lower limit side 14b of the longitudinal shaft-orientations top Norikazu edge of the ultrasonic horn 14. Through hole 14c of the ultrasonic horn 14 is made to penetrate the attachment shank 152 of the above-mentioned semiconductor chip attachment component 15. A mounting bolt 26 is screwed in in the direction which intersects perpendicularly with the longitudinal shaft orientations of the above-mentioned attachment shank 152 in tapped hole 14e from the ultrasonic horn 14 top Norikazu edge. It is fixing so that the tip of a mounting bolt 26 may be contacted to the attachment shank 152 and the attachment shank 152 of the above-mentioned semiconductor chip attachment component 15 may not fall out from the ultrasonic horn 14.

[0054] If it is made such structure, since the above-mentioned semiconductor chip attachment component 15 can be easily attached in the ultrasonic horn 14 by thrusting a mounting bolt 26 into the attachment shank 152 of the above-mentioned semiconductor chip attachment component 15, The semiconductor chip attachment component 15 from which whenever [champing-angle / of the semiconductor chip attachment component 15 and the attachment shank 1510] differs by loosening a mounting bolt 26, Or it can exchange for the semiconductor chip attachment component 15 which has the lower limit side which inclined to lower limit side 14b of the ultrasonic horn 14 easily, and whenever [champing-angle / of the semiconductor chip attachment component 15 to the ultrasonic horn 14] can adjust easily. According to the 2nd operation gestalt, the semiconductor chip attachment component 15 moreover, in the end section of the longitudinal shaft orientations of the ultrasonic horn 14 Since it can attach dismountable by thrusting a mounting bolt 26 into the ultrasonic horn 14, and being stopped towards the attachment shank 152 of the semiconductor chip attachment component 15, By loosening a mounting bolt 26, even if it can fix the semiconductor chip attachment component 15 firmly and dismountable and wears out the semiconductor chip attachment component 15 from the front of the ultrasonic horn 14, member exchange can be carried out easily.

[0055] (The 3rd operation gestalt) The 1st operation gestalt and the 2nd operation gestalt are different approaches, and the ultrasonic-jointing equipment for flip chip mounting which can enforce the ultrasonic-jointing approach for flip chip mounting concerning the 3rd operation gestalt of this invention fixes the above-mentioned semiconductor chip attachment component 15 to lower limit side 14b of the longitudinal shaft-orientations top Norikazu edge of the ultrasonic horn 14. That is, the direction which intersects perpendicularly with the straight side shaft-orientations top Norikazu edge of the ultrasonic horn 14 to the junction substrate 3 as shown in drawing 14 , and the **** 1531 which in other words 14d of tapped holes was cut along the vertical direction, and was prepared in the attachment shaft 153 of the semiconductor chip attachment component 15 of the above-mentioned round shape are thrust into the 14d of the above-mentioned tapped holes, and it is made to carry out conclusion immobilization of the above-mentioned semiconductor chip attachment component 15 at the ultrasonic horn 14 dismountable.

[0056] According to such structure, the conclusion immobilization of the semiconductor chip attachment component 15 can be easily carried out firmly and dismountable from the lower part of the ultrasonic horn 14 at the ultrasonic horn 14 by screwing in the screw thread 1531 of the attachment shaft 153 of the semiconductor chip attachment component 15 upward at the 14d of the above-mentioned tapped holes of lower limit side 14b of the longitudinal shaft-orientations top Norikazu edge of the ultrasonic horn 14. Therefore, even if it wears out the semiconductor chip attachment component 15, by loosening the screw thread 1531 of the attachment shaft 153 of the semiconductor chip attachment component 15 to 14d of tapped holes, the above-mentioned semiconductor chip attachment component 15 can be easily removed from the ultrasonic horn 14, and member exchange of the semiconductor chip attachment component 15 can be performed easily.

[0057] (The 4th operation gestalt) The ultrasonic-jointing equipment for flip chip mounting which can enforce the ultrasonic-jointing approach for flip chip mounting which starts the 4th operation gestalt of this invention at drawing 15 is shown. This 4th operation gestalt instead of fixing the semiconductor

chip attachment component 15 to the ultrasonic horn 14 directly at the end section of the longitudinal shaft orientations of the ultrasonic horn 14 The semiconductor chip attachment component 15 is arranged in the ultrasonic horn 14 through the flexurally oscillating section 141 which makes the longitudinal direction which intersects perpendicularly with the vertical direction by the supersonic vibration from the ultrasonic horn 14 generate flexural oscillation. It differs from the above 1st - the 3rd operation gestalt at the point which arranges the semiconductor chip attachment component 15 in the lower limit section of the flexurally oscillating section 141.

[0058] That is, as shown in drawing 15 , adsorption immobilization of the IC chip 6 is carried out at the semiconductor chip attachment component 15. The junction substrate 3 is fixed on the heating stage 4, and electronic parts 10 are carried on the junction substrate 3. A voice coil motor 11 is an example of the pressurizer which generates welding pressure 51, and a bracket 12 is formed in a part for the point of driving shaft 11a of the above-mentioned voice coil motor 11, and it is attached in the longitudinal direction in which the above-mentioned bracket 12 and the ultrasonic horn 14 cross at right angles with the vertical direction with whenever [5 degrees - 35 degree tilt-angle]. The pars intermedia of the flexurally oscillating section 141 which generates flexural oscillation is being fixed to the longitudinal direction which intersects perpendicularly with the vertical direction instead of the semiconductor chip attachment component 15 by the end face of the end section of the longitudinal shaft orientations of the above-mentioned ultrasonic horn 14. As shown in drawing 16 , the attachment shank 152 of the semiconductor chip attachment component 15 is inserted in through hole 141b of the lower limit section of the flexurally oscillating section 141, and it is fixing to it so that a mounting bolt 26 may be screwed in in tapped hole 141e of the flexurally oscillating section 141, the tip of a mounting bolt 26 may be contacted to the attachment shank 152 from the direction which intersects perpendicularly with the shaft orientations of the attachment shank 152 and the attachment shank 152 of the above-mentioned semiconductor chip attachment component 15 may not fall out from the flexurally oscillating section 141. In addition, through hole 141b which is open for free passage to suction hole 15b of the attachment shank 152 of the above-mentioned semiconductor chip attachment component 15 is equipped with suction path 141a further open for free passage at the flexurally oscillating section 141, and suction path 141a is connected with the piping 24 for suction.

[0059] Moreover, vibrator 13 is attached in the other end of the longitudinal shaft orientations of the ultrasonic horn 14 like the 1st - the 4th operation gestalt. An ultrasonic wave oscillator 17 is connected to the above-mentioned vibrator 13, and vibrator 13 is made to generate supersonic vibration. Moreover, motion control of the above-mentioned voice coil motor 11 is carried out with the junction pressurization control unit 16 like the 1st - the 4th operation gestalt.

[0060] Like the 1st - the 4th operation gestalt, in order that the semiconductor chip attachment component 15 may adsorb the IC chip 6, the piping 24 for suction is connected to the semiconductor chip attachment component 15, and the above-mentioned piping 24 for suction is supported by the bracket 12. The ultrasonic horn 14 is formed so that the mounting flanges 14a and 14a of the pair prolonged on both sides may be jutted out over the location of **** which hits the knot section of the longitudinal oscillation of the supersonic vibration which the above-mentioned vibrator 13 emits. By concluding each of this mounting flange 14a with a bolt 25, respectively to tie-down plate 12a divided into the two forks of a bracket 12 Conclusion immobilization is carried out at a bracket 12 with whenever [tilt-angle / toward which 5 degrees - 35 degrees of longitudinal shaft orientations of the ultrasonic horn 4 inclined to the longitudinal direction which intersects perpendicularly with the vertical direction].

[0061] The ultrasonic-jointing approach which used the ultrasonic-jointing equipment for the above-mentioned flip chip mounting for below is explained.

[0062] First, adsorption immobilization is carried out through the piping 24 for suction at the semiconductor chip attachment component 15, and through recognition actuation, the IC chip 6 avoids electronic parts 10 in the predetermined location of the junction substrate 3, and is positioned in it.

[0063] Subsequently, while the IC chip 6 moves the above-mentioned semiconductor chip attachment component 15 in the thickness direction of the IC chip 6 or the junction substrate 3 with the above-

mentioned ultrasonic-jointing equipment 1 for flip chip mounting, motion control is carried out with a voice coil motor 11 and the junction pressurization control device 16, and pressurization pushing for junction to the IC chip 6 and the junction substrate 3 is performed. A supersonic vibration signal is sent to the vibrator 13 of the ultrasonic horn 14 attached in the bracket 12 which could come, simultaneously was attached to the point of a voice coil motor 11 from an ultrasonic wave oscillator 17. The longitudinal oscillation generated from vibrator 13 is amplified in the ultrasonic horn 14, and supersonic vibration is given to the above-mentioned flexurally oscillating section 141 further prepared at the tip of the ultrasonic horn 14 along the vertical direction with whenever [tilt-angle / of 5 degrees - 35 degrees] to the longitudinal direction which intersects perpendicularly with the vertical direction. The friction transfer of this supersonic vibration is carried out at the IC chip 6 through the above-mentioned flexurally oscillating section 141 and the above-mentioned semiconductor chip attachment component 15, and metal junction of each bump 8 of the IC chip 6 and each electrode 9 of the junction substrate 3 is carried out. As whenever [above-mentioned tilt-angle], the above-mentioned range is chosen by the same reason as the above-mentioned 1st operation gestalt.

[0064] In order that the tip of the semiconductor chip attachment component 15 may carry out supersonic vibration in the direction of slant (for example, the direction of 5 degrees - 35 degree) to the longitudinal direction which intersects perpendicularly with the vertical direction to the IC chip 6 according to this 4th operation gestalt, pressurizing, the IC chip 6 carries out the same oscillating behavior to the semiconductor chip attachment component 15, supersonic vibration is stabilized, and it is transmitted to the IC chip 6. Thereby, sufficient bonding strength of the IC chip 6 and the junction substrate 3 is obtained, and junction dependability improves. Moreover, in order that the IC chip 6 may carry out the same oscillating behavior to the semiconductor chip attachment component 15, there is no damage to the IC chip 6 by the semiconductor chip attachment component 15.

[0065] Furthermore, according to the 4th operation gestalt, even if there is an obstruction like electronic parts 10, the semiconductor chip attachment component 15 is not being directly fixed to the ultrasonic horn 14. Since the semiconductor chip attachment component 15 is supported by the above-mentioned flexurally oscillating section 141 prolonged along the vertical direction in the ultrasonic horn 14, Since the flexurally oscillating section 141 can avoid electronic parts 10 and can position the IC chip 6 to the junction substrate 3, without the ultrasonic horn 14 contacting electronic parts 10, also when there is an obstruction like electronic parts 10, junction of the IC chip 6 can be ensured.

[0066] Moreover, according to the 4th operation gestalt, the attachment shank 152 of the semiconductor chip attachment component 15 is inserted upward in through hole 141b of the lower limit section of the flexurally oscillating section 141 of the ultrasonic horn 14 from a lower part. Since it is fixing from the direction which intersects perpendicularly with the shaft orientations of the attachment shank 152 so that the tip of a mounting bolt 26 may be contacted to the attachment shank 152 and the attachment shank 152 of the above-mentioned semiconductor chip attachment component 15 may not fall out from the flexurally oscillating section 141, The semiconductor chip attachment component 15 from which whenever [champing-angle / of the semiconductor chip attachment component 15 and the attachment shank 152] differs by loosening a mounting bolt 26, Or are easily exchangeable for the semiconductor chip attachment component 15 which has the lower limit side which inclined to the lower limit side of the flexurally oscillating section 141. Exchange is easy also when the semiconductor chip attachment component 15 is worn out, while whenever [champing-angle / of the semiconductor chip attachment component 15 to the flexurally oscillating section 141] can adjust easily.

[0067] (The 5th operation gestalt) The ultrasonic-jointing equipment for flip chip mounting which can enforce the ultrasonic-jointing approach for flip chip mounting which starts the 5th operation gestalt of this invention at drawing 17 - drawing 19 is shown. Instead of arranging the semiconductor chip attachment component 15 through the flexurally oscillating section 141 at the tip of the ultrasonic horn 14, the above-mentioned 5th operation gestalt is the point he is trying to arrange the semiconductor chip attachment component 15 through the flexurally oscillating section 141 to the pars intermedia of the ultrasonic horn 14, and differs from the above-mentioned 4th operation gestalt.

[0068] That is, as shown in drawing 17 , adsorption immobilization of the IC chip 6 is carried out at the

semiconductor chip attachment component 15. The junction substrate 3 is fixed on the heating stage 4, and electronic parts 10 are carried on the junction substrate 3. A voice coil motor 11 is an example of the pressurizer which generates welding pressure 51, a bracket 12 is formed in a part for the point of driving shaft 11a of the above-mentioned voice coil motor 11, and the ultrasonic horn 14 is attached in the above-mentioned bracket 12. This ultrasonic horn 14 on longitudinal direction both sides, respectively by two places, the knot section which carries out considerable to the knot of the longitudinal oscillation of an ultrasonic horn, respectively, and the knot section, a projection, As a rib 142,143 is once pulled out from the above-mentioned projecting **** and the knot section, it has whenever [tilt-angle / of 5 degrees - 35 degrees] to the longitudinal direction which intersects perpendicularly with the vertical direction and it is shown in drawing 17 and drawing 18 It bent at the right angle to the above-mentioned rib, i.e., the attachment section 144,145 bent in the direction of longitudinal oscillation is formed, and conclusion maintenance of the attachment section 144,145 is carried out with a bolt 25 to the above-mentioned bracket 12, respectively. Each of the two above-mentioned knot sections and the bond part of the ultrasonic horn 14 are taken as the following structures in detail. Namely, as the knot section by the side of a rib 143 shows to drawing 19 typically, in the knot section by the side of a rib 143, a rib 1431 is pulled out whenever [-] in a longitudinal direction from the both sides of the ultrasonic horn 14, respectively. The 1 1st bending section 1432 is formed. the direction of longitudinal oscillation from the above-mentioned rib 1431 -- a right angle -- bending -- the -- Bend at a right angle further from the 1st bending section 1432 in the opposite direction, and the 2nd bending section 1433 is formed. A rib 142,143 is formed in this 2nd bending section 1433, and it is considering as the configuration combined so that the attachment section 144,145 bent at the right angle to this rib 142,143 may be held to the above-mentioned pressurizer 11. The knot section by the side of the above-mentioned rib 142 is also considered as the same configuration.

[0069] Moreover, the flexurally oscillating section 141 is formed in the part of the antinode of the supersonic vibration between the above-mentioned **** and the knot section up and down. As shown in drawing 16 like the 4th operation gestalt, the attachment shank 152 of the semiconductor chip attachment component 152 is inserted in through hole 141b of the lower limit section of the above-mentioned flexurally oscillating section 141, and it is fixing to it so that a mounting bolt 26 may be screwed in in tapped hole 141e of the flexurally oscillating section 141, the tip of a mounting bolt 26 may be contacted to the attachment shank 152 from the direction which intersects perpendicularly with the shaft orientations of the attachment shank 152 and the attachment shank 152 of the above-mentioned semiconductor chip attachment component 15 may not fall out from the flexurally oscillating section 141. Vibrator 13 is attached in the other end of the ultrasonic horn 14 like the 1st - the 4th operation gestalt. An ultrasonic wave oscillator 17 is connected to the above-mentioned vibrator 13, and vibrator 13 is made to generate supersonic vibration. Moreover, motion control of the above-mentioned voice coil motor 11 is carried out with the junction pressurization control unit 16 like the 1st - the 4th operation gestalt.

[0070] Like the 1st - the 4th operation gestalt, in order that the semiconductor chip attachment component 15 may adsorb the IC chip 6, the piping 24 for suction is connected to the semiconductor chip attachment component 15, and the above-mentioned piping 24 for suction is supported by the bracket 12.

[0071] The ultrasonic-jointing approach which used the ultrasonic-jointing equipment for the above-mentioned flip chip mounting for below is explained.

[0072] First, adsorption immobilization is carried out through the piping 24 for suction at the semiconductor chip attachment component 15, and through recognition actuation, the IC chip 6 avoids electronic parts 10 in the predetermined location of the junction substrate 3, and is positioned in it.

[0073] Subsequently, while the IC chip 6 moves the above-mentioned semiconductor chip attachment component 15 in the thickness direction of the IC chip 6 or the junction substrate 3 with the above-mentioned ultrasonic-jointing equipment 1 for flip chip mounting, motion control is carried out with a voice coil motor 11 and the junction pressurization control device 16, and pressurization pushing for junction to the IC chip 6 and the junction substrate 3 is performed. A supersonic vibration signal is sent

to the vibrator 13 of the ultrasonic horn 14 attached in the bracket 12 which could come, simultaneously was attached to the point of a voice coil motor 11 from an ultrasonic wave oscillator 17. In the above-mentioned flexurally oscillating section 141 prepared in along the vertical direction at the part which amplifies the longitudinal oscillation generated from vibrator 13 in the ultrasonic horn 14, and is further equivalent to the antinode of the supersonic vibration between the above-mentioned **** of the ultrasonic horn 14, and the knot section Supersonic vibration is given with whenever [5 degrees - 35 degree tilt-angle] to the longitudinal direction which intersects perpendicularly with the vertical direction. The friction transfer of this supersonic vibration is carried out at the IC chip 6 through the above-mentioned flexurally oscillating section 141 and the above-mentioned semiconductor chip attachment component 15, and metal junction of each bump 8 of the IC chip 6 and each electrode 9 of the junction substrate 3 is carried out.

[0074] In order that the tip of the semiconductor chip attachment component 15 may carry out supersonic vibration in the direction of slant (for example, the direction of 5 degrees - 35 degree) to the longitudinal direction which intersects perpendicularly with the vertical direction to the IC chip 6 according to this 5th operation gestalt, pressurizing, the IC chip 6 carries out the same oscillating behavior to the semiconductor chip attachment component 15, supersonic vibration is stabilized, and it is transmitted to the IC chip 6. Thereby, sufficient bonding strength of the IC chip 6 and the junction substrate 3 is obtained, and junction dependability improves. Moreover, in order that the IC chip 6 may carry out the same oscillating behavior to the semiconductor chip attachment component 15, there is no damage to the IC chip 6 by the semiconductor chip attachment component 15.

[0075] Furthermore, according to the 5th operation gestalt, even if there is an obstruction like electronic parts 10, the semiconductor chip attachment component 15 is not being directly fixed to the ultrasonic horn 14. Since the semiconductor chip attachment component 15 is supported by the above-mentioned flexurally oscillating section 141 prolonged along the vertical direction in the ultrasonic horn 14, Since the flexurally oscillating section 141 can avoid electronic parts 10 and can position the IC chip 6 to the junction substrate 3, without the ultrasonic horn 14 contacting electronic parts 10, also when there is an obstruction like electronic parts 10, junction of the IC chip 6 can be ensured.

[0076] Moreover, without according to the 5th operation gestalt, the parallelism between IC chip maintenance side which is a lower limit side of the semiconductor chip attachment component 15, and the plane of composition of the junction substrate 3 collapsing, since it is both the **** structure over welding pressure 51 by the knot section and the knot section of the ultrasonic horn 14 even if the welding pressure 51 by the voice coil motor 11 becomes large, to the IC chip 6, supersonic vibration can be stabilized and it can transmit. Moreover, even if distortion occurs with a pressurization load etc. in clamp-face 12a of the ultrasonic horn 14, in order that the rib structure of having the above-mentioned attachment section 142,143 may carry out elastic deformation and may absorb the distortion, the resonance state stabilized without distorting the ultrasonic horn 14 can be maintained, sufficient bonding strength of the IC chip 6 and the junction substrate 3 is obtained, and junction dependability improves.

[0077] Moreover, according to the 5th operation gestalt, the attachment shank 152 of the semiconductor chip attachment component 15 is inserted upward in through hole 141b of the lower limit section of the flexurally oscillating section 141 of the ultrasonic horn 14 from a lower part. Since it is fixing from the direction which intersects perpendicularly with the shaft orientations of the attachment shank 152 so that the tip of a mounting bolt 26 may be contacted to the attachment shank 152 and the attachment shank 152 of the above-mentioned semiconductor chip attachment component 15 may not fall out from the flexurally oscillating section 141, The semiconductor chip attachment component 15 from which whenever [champing-angle / of the semiconductor chip attachment component 15 and the attachment shank 152] differs by loosening a mounting bolt 26, Or are easily exchangeable for the semiconductor chip attachment component 15 which has the lower limit side which inclined to the lower limit side of the flexurally oscillating section 141. Exchange is easy also when the semiconductor chip attachment component 15 is worn out, while whenever [champing-angle / of the semiconductor chip attachment component 15 to the flexurally oscillating section 141] can adjust easily.

[0078] (The 6th operation gestalt) As for the ultrasonic-jointing equipment for flip chip mounting which

can enforce the ultrasonic-jointing approach for flip chip mounting concerning the 6th operation gestalt of this invention, the maintenance structure of the semiconductor chip attachment component 15 in the lower limit section of the flexurally oscillating section 141 differs from a 4th and 5 operation gestalt. Namely, as shown in drawing 20 , the maintenance structure of the semiconductor chip attachment component 15 in the lower limit section of the flexurally oscillating section 141 The attachment shank 152 which formed the rate bundle hole 146 in the flexurally oscillating section 141, and was prepared in it at the above-mentioned semiconductor chip attachment component 15 at the rate bundle hole 146 is inserted. By preparing tapped hole 146a in the above-mentioned rate bundle hole 146 at right angles to the shaft orientations of the attachment shank 152, and thrusting a mounting bolt 27 into tapped hole 146a The attachment shank 152 of the above-mentioned semiconductor chip attachment component 15 is grasped by the inside of the above-mentioned rate bundle hole 146, and it is made to carry out conclusion immobilization of the above-mentioned semiconductor chip attachment component 15 at the above-mentioned flexurally oscillating section 141.

[0079] According to such a 6th operation gestalt, the attachment shank 152 of the semiconductor chip attachment component 15 is inserted upward from a lower part into the rate bundle hole 146 of the lower limit section of the flexurally oscillating section 141 of the ultrasonic horn 14. By thrusting a mounting bolt 27 into tapped hole 146a formed at right angles to the shaft orientations of the rate bundle hole 146 The attachment shank 152 of the above-mentioned semiconductor chip attachment component 15 is grasped by the inside of the above-mentioned rate bundle hole 146, and it is made to carry out conclusion immobilization of the above-mentioned semiconductor chip attachment component 15 at the above-mentioned flexurally oscillating section 141. For this reason, exchange is easy also when the semiconductor chip attachment component 15 is worn out, while it can exchange for the semiconductor chip attachment component 15 from which whenever [champing-angle / of the semiconductor chip attachment component 15 and the attachment shank 152] differs by loosening a mounting bolt 27, or the semiconductor chip attachment component 15 which has the lower limit side which inclined to the lower limit side of the flexurally oscillating section 141 easily and whenever [champing-angle / of the semiconductor chip attachment component 15 to the flexurally oscillating section 141] can adjust easily.

[0080] (The 7th operation gestalt) As for the ultrasonic-jointing equipment for flip chip mounting which can enforce the ultrasonic-jointing approach for flip chip mounting concerning the 7th operation gestalt of this invention, the maintenance structure of the semiconductor chip attachment component 15 in the lower limit section of the flexurally oscillating section 141 differs from a 4th, 5, and 6 operation gestalt. Namely, as shown in drawing 21 , the maintenance structure of the semiconductor chip attachment component 15 in the lower limit section of the flexurally oscillating section 141 The flexurally oscillating section 141 prepared in along the vertical direction of the ultrasonic horn 14 which gives supersonic vibration in the direction of slant to the longitudinal direction which intersects perpendicularly the above-mentioned semiconductor chip attachment component 15 with the vertical direction to the IC chip 6 The perpendicular through hole 1411 was formed to the plane of composition of the junction substrate 3, and the inclined plane 1412 of the 20 degrees - 40 degrees roofing which spread downward in the lower limit section, or a cone mold is formed. The semiconductor chip attachment component 154 equivalent to the above-mentioned semiconductor chip attachment component 15 holds the IC chip 6 from a longitudinal direction to disc-like semiconductor chip attaching part 154a of the lower limit section, forms the somewhat larger hollow 1541 than the IC chip 6 for making it there be no dedropping on a longitudinal direction, and is enabling loosely fitting of the IC chip 6 through the clearance in the hollow 1541 while it forms the slit 1543 prolonged upward to a center section in the core from a lower limit side. moreover, the inclined plane 1412 of the roofing prepared in the upper part of disc-like semiconductor chip attaching part 154a of the semiconductor chip attachment component 154 at the above-mentioned flexurally oscillating section 141, or a cone mold and a profile -- the inclined plane 1542 of whenever [same tilt-angle] is formed, the attachment shank 1544 is formed on it, and it is constituted. If it is pressurized downward with the above-mentioned pressurizer 11 as shown by welding pressure 51, the inclined plane 1412 of the above-mentioned

flexurally oscillating section 141 and the inclined plane 1542 of the above-mentioned semiconductor chip attachment component 154 engage and contact, and the above-mentioned flexurally oscillating section 141 and the above-mentioned semiconductor chip attachment component 154 are constituted so that the semiconductor chip attachment component 154 may put the IC chip 6. Moreover, ball 28a at the tip of a ball plunger 28 established in the above-mentioned flexurally oscillating section 141 is pressed against the notch 1545 cratered in the shape of [which was prepared in the side face of the pars intermedia of the attachment shank 1544] a cone at right angles to the shaft orientations of the attachment shank 1544, and the above-mentioned semiconductor chip attachment component 154 is constituted so that the above-mentioned semiconductor chip attachment component 154 can pull up upward in one with the above-mentioned flexurally oscillating section 141.

[0081] The ultrasonic-jointing approach which used the ultrasonic-jointing equipment for the above-mentioned flip chip mounting for below is explained.

[0082] First, adsorption immobilization is carried out through the piping 24 for suction at the semiconductor chip attachment component 154, and the IC chip 6 is positioned through recognition actuation in the predetermined location of the junction substrate 3.

[0083] Subsequently, while the IC chip 6 moves the above-mentioned semiconductor chip attachment component 15 in the thickness direction of the IC chip 6 or the junction substrate 3 with the above-mentioned ultrasonic-jointing equipment 1 for flip chip mounting, motion control is carried out with a voice coil motor 11 and the junction pressurization control device 16, and pressurization pushing by the welding pressure 51 for junction of the IC chip 6 and the junction substrate 3 is performed. this welding pressure 51 -- the inclined plane 1412 of the cone mold of the lower limit section of the flexurally oscillating section 141 -- the profile of the semiconductor chip attachment component 154 -- the inclined plane 1542 of the same inclination is stuffed downward with welding pressure 52. As shown in drawing 21 , the whole semiconductor chip attachment component 154 bends so that the slit 1543 to which the component of a force 53 of this welding pressure 52 was formed in the semiconductor chip attachment component 154 by working in a longitudinal direction may be narrowed, and it bends in the direction in which the insides of the hollow 1541 of the semiconductor chip attachment component 154 approach along a longitudinal direction mutually, and the IC chip 6 is put by the inside of a hollow 1541. Then, a supersonic vibration signal is sent to the vibrator 13 of the ultrasonic horn 14 attached in the bracket 12 attached in the point of a voice coil motor 11 from an ultrasonic wave oscillator 17, the ultrasonic horn 14 amplifies the longitudinal oscillation generated from vibrator 13, and supersonic vibration is given to the above-mentioned flexurally oscillating section 141 further prepared in along the vertical direction at the ultrasonic horn 14. This supersonic vibration is mechanically transmitted to the IC chip 6, and metal junction of each bump 8 of the IC chip 6 and each electrode 9 of the junction substrate 3 is carried out.

[0084] Then, motion control is carried out to a voice coil motor 11 by junction pressurization control **** 16, the welding pressure 51 of pressurization pushing serves as zero, the welding pressure 52 between the inclined plane 1412 of the cone mold at the tip of the flexurally oscillating section 141 and the inclined plane 1542 of the semiconductor chip attachment component 154 also serves as zero, and the component of a force 53 of this welding pressure 52 also serves as ZE opening. Consequently, a slit 1543 returns to the original spacing according to the elastic force of the semiconductor chip attachment component 154, and motion control is carried out so that the inside of the hollow 1541 of the semiconductor chip attachment component 154 separates from the side face of the IC chip 6, and the flexurally oscillating section 141 and the semiconductor chip attachment component 154 may be raised in one and may separate from the IC chip 6 with a voice coil motor 11 and the junction pressurization control device 16.

[0085] In order to give supersonic vibration according to this 7th operation gestalt, the lower limit section of the semiconductor chip attachment component 154 putting the IC chip 6 from both sides mechanically pressurizing, the IC chip 6 carries out the same oscillating behavior to the semiconductor chip attachment component 154, and supersonic vibration is stabilized and transmitted to the IC chip 6 from the semiconductor chip attachment component 154. Thereby, sufficient bonding strength of the IC chip 6 and the junction substrate 3 is obtained, and junction dependability improves. Moreover, in order

that the IC chip 6 may carry out the same oscillating behavior to the semiconductor chip attachment component 154, there is no damage to the IC chip 6 by the semiconductor chip attachment component 154.

[0086] In addition, this invention is not limited to the above-mentioned operation gestalt, and can be carried out in various modes.

[0087] For example, you may make it have an adjusting device 29 whenever [tilt-angle / which can adjust whenever / tilt-angle / for the include angle theta of the ultrasonic horn 14 to the any value within the limits of 5 degrees - the above-mentioned 35 degrees] according to junction conditions, such as the quality of the material of the IC chip 6, thickness, or the quality of the material of a substrate 3, thickness, as shown in drawing 22 . The adjusting device 29 has the following structures whenever [this tilt-angle].

[0088] That is, the 1st spherical bearing 36 consists of spherical-surface-like heights 38 and a spherical-surface-like crevice 37 by making it energize with a spring 34 so that the spherical-surface-like heights 38 may be formed in a bracket 12, and the spherical-surface-like crevice 37 which slides on the spherical-surface-like heights 38 may be established in the supporter material 35 which supports a bracket 12 and the spherical-surface-like heights 38 and the spherical-surface-like crevice 37 may always contact. Moreover, when forming in the front face of the spherical-surface-like crevice 37 of the 1st spherical bearing 36 suction puncturing which is open for free passage to the 1st suction path 31 and carrying out suction actuation by the 1st suction path 31, while the spherical-surface-like heights 38 and the spherical-surface-like crevice 37 are fixed improper [migration], when loosening suction actuation, the spherical-surface-like heights 38 and the spherical-surface-like crevice 37 suppose relatively that it is movable. The include-angle adjusting screw 39 is thrust into tapped hole 12e of the upper limit section of a bracket 12, and the tip is made to contact the side face of the supporter material 35. Therefore, by turning the include-angle adjusting screw 39, it restricts to the time when suction actuation at the 3rd suction path 33 is loosened, and it is supposed that it is movable in the direction in which the upper limit section of a bracket 12 attaches and detaches to the supporter material 35.

[0089] Moreover, the 2nd spherical bearing 134 consists of 15f of spherical-surface-like heights, and 14f of spherical-surface-like crevices by forming 14f of spherical-surface-like crevices in the lower limit section of the ultrasonic horn 14, and forming in the upper part of the semiconductor chip attachment component 15 15f of spherical-surface-like heights which can slide on 14f of spherical-surface-like crevices. Moreover, when forming in the front face of 14f of spherical-surface-like crevices of the 2nd spherical bearing 134 suction puncturing which is open for free passage to the 2nd suction path 32 and carrying out suction actuation by the 2nd suction path 32, while 15f of spherical-surface-like heights and 14f of spherical-surface-like crevices are fixed improper [migration], when loosening suction actuation, 15f of spherical-surface-like heights and 14f of spherical-surface-like crevices suppose relatively that it is movable. Moreover, the ultrasonic horn 14 enables adjustment of theta support or by being supported pivotable with structure as shown in the previous operation gestalt to a bracket 12 whenever [tilt-angle / of the ultrasonic horn 14 to a bracket 12].

[0090] Thus, after loosening the vaccum pressure in suction actuation at the 1st suction path 31 to an atmospheric-pressure side by constituting, by turning the include-angle adjusting screw 39, to the supporter material 35, the upper limit section of a bracket 12 makes it move in the direction which approaches or deserts, slides the spherical-surface-like heights 38 of the 1st spherical bearing 36 to the spherical-surface-like crevice 37, and shakes theta whenever [tilt-angle / of the 1st spherical bearing 36]. Consequently, theta is shaken whenever [tilt-angle / of the ultrasonic horn 14], and theta is fixed by vacuum adsorption whenever [tilt-angle / of the ultrasonic horn 14] by raising the vaccum pressure in suction actuation at the 1st suction path 31.

[0091] The vaccum pressure in suction actuation at the 2nd suction path 32 in subsequently, the condition of having loosened to the atmospheric pressure side The lower limit side (IC chip adsorption side) of the semiconductor chip attachment component 15 is pressed against the top face (substrate installation side) of the heating stage 4. Where it slid 15f of spherical-surface-like heights of the 2nd spherical bearing 134 to 14f of spherical-surface-like crevices in the 2nd spherical bearing 134 and the

parallelism of the lower limit side of the semiconductor chip attachment component 15 and the top face of the heating stage 4 is sent The vaccum pressure in suction actuation at the 2nd suction path 32 is raised, the lower limit side of the semiconductor chip attachment component 15 and the top face of the heating stage 4 are held to abbreviation parallel, and theta is fixed whenever [tilt-angle] by vacuum adsorption maintenance. Then, the semiconductor chip attachment component 15 is moved and vacuum adsorption maintenance of the IC chip 6 in respect of the lower limit of the semiconductor chip attachment component 15 is performed in suction actuation at the 3rd suction path 33 which has the piping 24 for suction.

[0092] According to such a configuration, junction conditions, such as the quality of the material of the IC chip 6, thickness, or the quality of the material of a substrate 3, thickness, can adjust [whenever / tilt-angle] whenever [tilt-angle] for theta to the any value within the limits of 5 degrees - the above-mentioned 35 degrees whenever [tilt-angle / of the ultrasonic horn 14] with an adjusting device 29. Moreover, the junction condition of the IC chip 6 can be seen and theta can be tuned finely whenever [tilt-angle / of the ultrasonic horn 14].

[0093] Moreover, this invention is not applied only to the ultrasonic-jointing approach for flip chip mounting, and ultrasonic-jointing equipment, but can be applied to other applications. For example, it is applicable also to the bump formation approach and equipment which form a bump 8 in electronic parts, such as the IC chip 6. An example is shown in drawing 23 . in drawing 23 , while laying the IC chip 6 which is an object on the heating stage 41, the rotation supporting point of a base attaches in X-Y table 48 -- having -- and the capillary mechanical component 49 -- the supporter material 46 rockable to the circumference of the rotation supporting point -- the ultrasonic horn 42 and a gold streak -- the clamper 43 is supported. a gold streak -- the tip of a clamper 43 -- a gold streak -- the capillary 47 holding the gold streak 45 supplied giving predetermined tension from a tensioner 44 is arranged. The ultrasonic horn 42 has set theta as the any value within the limits of 5 degrees - the above-mentioned 35 degrees whenever [tilt-angle] like each above-mentioned operation gestalt.

[0094] according to the bump formation equipment of such a configuration -- a gold streak -- melting of the lower limit of the gold streak 45 which the capillary 47 was supplied from the tensioner 44 and projected from the lower limit of a capillary 47 is carried out by discharge etc., and a ball is formed. Then, the location of the capillary 47 to the IC chip 6 on the heating stage 41 is positioned by X-Y table 48 in the XY direction which is a 2-way which intersects perpendicularly. then, the capillary mechanical component 49 -- the circumference of the rotation supporting point -- the ultrasonic horn 42 and a gold streak -- a clamper 43 is made to rock, the formed ball is pushed against the IC chip 6 on the heating stage 41 through a capillary 47, supersonic vibration is given from the ultrasonic horn 42, and a bump 8 is formed on the pad of the IC chip 6.

[0095] Thus, also when forming a bump 8 on the pad of the IC chip 6, the ultrasonic horn 42 will be made to carry out bump formation by giving supersonic vibration from across to the longitudinal direction which intersects a bump 8 perpendicularly with the vertical direction to the IC chip 6 (the direction of 5 degrees - 35 degree), if it puts in another way by setting theta as the any value within the limits of 5 degrees - the above-mentioned 35 degrees whenever [tilt-angle]. Therefore, the gold streak 45 held at the capillary 47 carries out the same oscillating behavior to the ultrasonic horn 42, and supersonic vibration is stabilized, it is transmitted to a gold streak 45, sufficient bonding strength of the bump 8 and the IC chip 6 which are formed of a gold streak 45 is obtained, and junction quality can be raised. Moreover, since the bump 8 formed of a gold streak 45 does the same oscillating behavior to the ultrasonic horn 42, there is no damage to the IC chip 6 by the ultrasonic horn 42, and a goods image can also be raised.

[0096] in addition, the above -- each effectiveness which it has can be done so by combining suitably the operation gestalt of the arbitration of the various operation gestalten.

[0097]

[Effect of the Invention] As mentioned above, he is trying to join a semiconductor chip to a junction substrate by giving supersonic vibration from across to the longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip (the direction of 5 degrees

- 35 degree) according to the ultrasonic-jointing approach for flip chip mounting of this invention, and ultrasonic-jointing equipment, as explained in full detail. Therefore, a semiconductor chip carries out the same oscillating behavior to a semiconductor chip attachment component, and supersonic vibration is stabilized, it is transmitted to a semiconductor chip, sufficient bonding strength of a semiconductor chip and a junction substrate is obtained, and junction quality can be raised. Moreover, since a semiconductor chip carries out the same oscillating behavior to a semiconductor chip attachment component, there is no damage to the semiconductor chip by the semiconductor chip attachment component, and a goods image can also be raised.

[0098] Moreover, it sets to the ultrasonic-jointing approach for flip chip mounting of this invention, and ultrasonic-jointing equipment. In the process which carries out flip chip mounting of the semiconductor chip on a substrate After [substrate] carrying out alignment, if supersonic vibration is given in the direction of slant (the direction of 5 degrees - 35 degree) to the longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip to a semiconductor chip and it is made to join, forming a bump in a semiconductor chip and pressurizing it, the tip of a semiconductor chip attachment component In order to carry out supersonic vibration in the direction of slant (the direction of 5 degrees - 35 degree) to the longitudinal direction along the above-mentioned plane of composition of the above-mentioned semiconductor chip to a semiconductor chip, pressurizing, a semiconductor chip carries out the same oscillating behavior to a semiconductor chip attachment component, supersonic vibration is stabilized, and it is transmitted to a semiconductor chip. Thereby, sufficient bonding strength of a semiconductor chip and a junction substrate is obtained, and junction dependability improves. Moreover, in order that a semiconductor chip may carry out the same oscillating behavior to a semiconductor chip attachment component, there is no damage to the semiconductor chip by the semiconductor chip attachment component.

[0099] In the ultrasonic-jointing equipment for flip chip mounting of this invention, the parallelism between the apical surface of a semiconductor chip attachment component and the plane of composition of a junction substrate is maintained, without an ultrasonic horn inclining to ********, even if the welding pressure by the voice coil motor becomes large. Moreover, even if distortion occurs in the knot of an ultrasonic horn, the amplitude to a semiconductor chip is stabilized, without the resonance state of an ultrasonic horn collapsing. Thereby, sufficient bonding strength of a semiconductor chip and a junction substrate is obtained, and junction dependability improves.

[0100] Moreover, in the ultrasonic-jointing equipment for flip chip mounting of this invention, in order to prepare the flexurally oscillating section at the tip of the longitudinal-oscillation section of an ultrasonic horn by one apparatus along the vertical direction, an ultrasonic vibrational state is stabilized and the amplitude of a semiconductor chip is stabilized. Thereby, sufficient bonding strength of a semiconductor chip and a **** substrate is obtained, and junction dependability improves.

[0101] Moreover, in the ultrasonic-jointing equipment for flip chip mounting of this invention, without a semiconductor chip being slippery to a semiconductor chip attachment component, in order that the tip of a semiconductor chip attachment component may put and carry out supersonic vibration of the semiconductor chip mechanically, supersonic vibration is stabilized and it is transmitted to a semiconductor chip. Thereby, sufficient bonding strength of a semiconductor chip and a junction substrate is obtained, and junction dependability improves. Moreover, in order that a semiconductor chip may carry out the same oscillating behavior to a semiconductor chip attachment component, there is no damage to the semiconductor chip by the semiconductor chip attachment component.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] (A) and (B) are the explanatory views showing the process of the ultrasonic-jointing approach for flip chip mounting of the 1st operation gestalt of this invention, respectively.
[Drawing 2] It is the front view of the ultrasonic-jointing equipment for flip chip mounting of the above-mentioned 1st operation gestalt.
[Drawing 3] It is the front view showing the maintenance structure of the semiconductor chip attachment component of the ultrasonic-jointing equipment for the above-mentioned flip chip mounting.

[Drawing 4] (A) and (B) are the front views showing the attaching structure of the ultrasonic horn of the ultrasonic-jointing equipment for the above-mentioned flip chip mounting, respectively.
[Drawing 5] In the comparison with the ultrasonic-jointing approach for flip chip mounting of the above-mentioned 1st operation gestalt, and the conventional ultrasonic-jointing approach, it is drawing showing the relation between the number of the bump in IC chip, and the rate of poor junction.
[Drawing 6] In the ultrasonic-jointing approach for flip chip mounting of the above-mentioned 1st operation gestalt, it is the explanatory view showing that supersonic vibration has the component of the vertical direction, i.e., a Z direction.
[Drawing 7] It is the explanatory view showing the comparison of the jointing time in the comparison with the above-mentioned 1st operation gestalt and the ultrasonic-jointing approach for the conventional flip chip mounting.
[Drawing 8] It is the explanatory view showing the relation between the above-mentioned 1st operation gestalt, the collet of the above-mentioned semiconductor chip attachment component of the ultrasonic-jointing equipment for the conventional flip chip mounting, and IC chip.
[Drawing 9] It is the explanatory view showing the relation between the supersonic vibration in the ultrasonic-jointing approach for flip chip mounting of the above-mentioned 1st operation gestalt, and the welding pressure of the vertical direction.
[Drawing 10] It is the graph which shows the relation between the supersonic vibration in the ultrasonic-jointing approach for flip chip mounting of the above-mentioned 1st operation gestalt, and the welding pressure of the vertical direction.
[Drawing 11] It is the perspective view of the ultrasonic-jointing equipment for flip chip mounting of the 1st operation gestalt of this invention.
[Drawing 12] It is the perspective view of the ultrasonic-jointing head section of the ultrasonic-jointing equipment for flip chip mounting of drawing 11 .
[Drawing 13] It is the front view showing the maintenance structure of the semiconductor chip attachment component of the 2nd operation gestalt of this invention.
[Drawing 14] It is the front view showing the maintenance structure of the semiconductor chip attachment component of the 3rd operation gestalt of this invention.
[Drawing 15] It is the front view of the ultrasonic-jointing equipment for flip chip mounting of the 4th operation gestalt of this invention.

[Drawing 16] (A), (B), and (C) are the left-hand side sectional view (X-X-ray sectional view in drawing 1616 (B)) showing the maintenance structure of the semiconductor chip attachment component of the ultrasonic-jointing equipment for flip chip mounting of the above-mentioned 4th operation gestalt, respectively, a front view, and a bottom view.
[Drawing 17] It is the front view of the ultrasonic-jointing equipment for flip chip mounting of the 5th operation gestalt of this invention.
[Drawing 18] (A) and (B) are the top views and front views of an ultrasonic horn of ultrasonic-jointing equipment for flip chip mounting of the above-mentioned 5th operation gestalt, respectively.
[Drawing 19] (A) and (B) are the top views and front views of the ultrasonic horn anchoring section of ultrasonic-jointing equipment for flip chip mounting of the above-mentioned 5th operation gestalt, respectively.
[Drawing 20] (A), (B), and (C) are the left-hand side sectional view (X-X-ray sectional view in drawing 20 (B)) showing the maintenance structure of the semiconductor chip attachment component of the ultrasonic-jointing equipment for flip chip mounting of the 6th operation gestalt of this invention, respectively, a front view, and a bottom view.
[Drawing 21] the maintenance structure of the semiconductor chip attachment component of the ultrasonic-jointing equipment for flip chip mounting of the 7th operation gestalt of this invention is shown -- it is a cross-section front view a part.
[Drawing 22] It is the front view of the ultrasonic-jointing equipment which has an adjusting device for whenever [tilt-angle / of the ultrasonic horn of the ultrasonic-jointing equipment for flip chip mounting of other operation gestalten of this invention] whenever [tilt-angle / which can be adjusted].
[Drawing 23] It is the front view of the bump formation equipment in which the example which applied this invention to the bump formation approach and equipment is shown.
[Drawing 24] It is the perspective view of the conventional flip chip ultrasonic-jointing facility.
[Drawing 25] It is the perspective view of the conventional flip chip ultrasonic-jointing head section.
[Drawing 26] It is the front view of the conventional flip chip supersonic-wave horn.
[Drawing 27] (A) and (B) are the part plans and side elevations showing the junction condition of the IC chip and the substrate which were joined by the conventional flip chip supersonic-wave horn, respectively.
[Description of Notations]
1 -- Ultrasonic-jointing equipment for flip chip mounting, 1 A--IC chip extractor, 2A [-- Heating stage,] -- A substrate transport device, 2B -- A substrate transport device, 3 -- A substrate, 4 5 [-- Heating control unit,] -- A wafer sheet, 6 -- IC chip, 6a -- A pad, 7 8 [-- Voice coil motor,] -- A bump, 9 -- An electrode, 10 -- Electronic parts, 11 11a [-- Tie-down plate,] -- A driving shaft, 111 -- Welding pressure, 12 -- A bracket, 12a 12e [-- Mounting flange,] -- A tapped hole, 13 -- An ultrasonic vibrator, 14 -- An ultrasonic horn, 14a 14b [-- Tapped hole,] -- A lower limit side, 14c -- A through hole, 14d -- A tapped hole, 14e 14f -- A spherical-surface-like crevice, 141 -- The flexurally oscillating section, 141a -- Suction path, 141b [-- Inclined plane,] -- A through hole, 141e -- A tapped hole, 1411 -- A through hole, 1412 142,143 -- A rib, 144,145 -- The attachment section, 1431 -- Rib, 1432 -- The 1st bending section, 1433 -- The 2nd bending section, 146 -- Rate bundle hole, 146a -- A tapped hole, 15 -- A semiconductor chip attachment component, 15a -- Collet, 15b [-- It ****s.] -- A suction hole, 15f -- Spherical-surface-like heights, 1510 -- An attachment shank, 1511 152 [-- Semiconductor chip attachment component,] -- An attachment shank, 153 -- An attachment shank, 1531 -- It ****s and is 154. 154a -- A semiconductor chip attaching part, 1541 -- It becomes depressed and is 1542. -- Inclined plane, 1543 [-- Junction pressurization control unit,] -- A slit, 1544 -- An attachment shank, 1545 -- A notch, 16 17 -- An ultrasonic wave oscillator, 20 -- The direction of supersonic vibration of an ultrasonic horn, 21 -- The direction of supersonic vibration of IC chip, 24 [-- Mounting bolt,] -- Piping for suction, 25 -- A bolt, 251 -- A nut, 26 27 [-- Whenever / tilt-angle / Adjusting device,] -- A mounting bolt, 28 -- A ball plunger, 28a -- A ball, 29 30 -- Flip chip mounting equipment, 31 -- The 1st suction path, 32 -- The 2nd suction path, 33 [-- The 1st spherical bearing,] -- The 3rd suction path, 134 -- A spring, 35 -- Supporter material, 36 37 [-- Heating stage,] -- A spherical-surface-like crevice, 38 --

Spherical-surface-like heights, 39 -- An include-angle adjusting screw, 41 42 -- supersonic-wave horn and 43 -- a gold streak -- a clamper and 44 -- a gold streak -- a tensioner and 45 -- a gold streak, 46 -- supporter material, and 47 -- a capillary, 48 -- X-Y table, 49 -- capillary mechanical component, 51, and 52 -- welding pressure, 53 -- component of a force, and the 134 -- 2nd spherical bearing.

[Translation done.]

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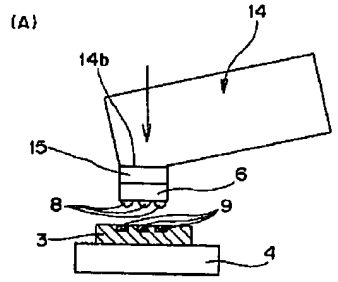
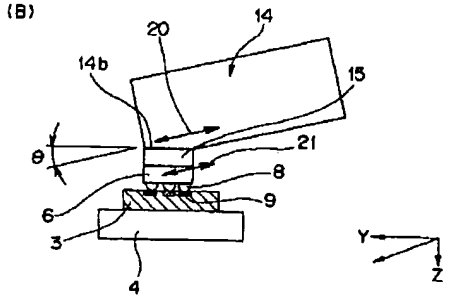
(54)【発明の名称】　超音波接合方法とその装置

(57)【要約】
【課題】　電子部品と基板との十分な接合強度が得られ、安定した接合が行えるフリップチップ実装用超音波接合方法及び装置を提供する。
【解決手段】　基板３に対して半導体チップ６を上下方向と直交する横方向に対して斜め方向（５°～３５°方向）から超音波振動を与えることで接合する。よって、ＩＣチップが半導体チップ保持部材１５に対し同じ振動挙動をし、超音波振動が安定してＩＣチップに伝達され、ＩＣチップと接合基板との十分な接合強度が得られ、接合品質を向上させることができる。





【特許請求の範囲】

【請求項１】　半導体チップ（６）を基板（３）上にフリップチップ実装するとき、上記半導体チップのパッド（６ａ）上のバンプ（８）と、上記基板の電極（９）と位置合わせし、

その後、加圧しながら上記半導体チップに対して上記半導体チップの上記接合面沿いの横方向に対して斜め方向に超音波振動を与えつつ、上記半導体チップの上記バンプを上記基板の上記電極に接合することを特徴とする超音波接合方法。

【請求項２】　上記半導体チップに対する上記半導体チップの上記接合面沿いの横方向に対して斜め方向に上記超音波振動を与える傾斜角度（θ）が５度～３５度である請求項１に記載の超音波接合方法。

【請求項３】　請求項１又は２に記載の超音波接合方法により上記半導体チップが接合された基板。

【請求項４】　半導体チップ（６）に加圧及び超音波振動を与えて基板（３）に上記半導体チップを接合する超音波接合装置において、

上記半導体チップの接合面を上記基板の接合面に対し略平行を保ちつつ保持する半導体チップ保持部材（１５）と、

上記半導体チップ保持部材に保持された上記半導体チップに、上記半導体チップの上記接合面沿いの横方向に対して斜め方向に上記超音波振動を与える超音波ホーン（１４）と、

上記超音波ホーンに上記超音波振動を与える振動子（１３）と、

上記超音波ホーンを保持し、かつ、上記半導体チップ保持部材を介して上記半導体チップに上記基板に対して加圧力を与える加圧装置（１１）とを備えることを特徴とする超音波接合装置。

【請求項５】　上記半導体チップ保持部材を上記半導体チップに対して上記半導体チップの上記接合面沿いの横方向に対して斜め方向に上記超音波振動を与える上記超音波ホーンの上記超音波振動の傾斜角度（θ）が５度～３５度である請求項４に記載の超音波接合装置。

【請求項６】　上記超音波ホーンの先端に、上記基板の接合面に対して直交する方向に延びる穴（１４ｃ）を設け、その穴に上記半導体チップ保持部材に設けた取付軸部（１５１０）を挿入し、その取付軸部にねじ（１５１１）を設け、そのねじと該ねじにねじ込まれるナット（２５１）とで上記超音波ホーンの先端に上記半導体チップ保持部材を取り外し可能に固定する請求項４に記載の超音波接合装置。

【請求項７】　上記超音波ホーン先端に、上記基板の接合面に対して直交する方向に延びる穴（１４ｃ）を設け、その穴に上記半導体チップ保持部材に設けた取付軸部（１５２）を挿入し、その取付軸部に直交するように上記超音波ホーンの先端で延びるねじ穴（１４ｅ）を設け、上記ねじ穴と該ねじ穴にねじ込まれる取付ねじ（２６）とで上記超音波ホーンの先端に上記半導体チップ保持部材を取り外し可能に固定する請求項４に記載の超音波接合装置。

【請求項８】　上記超音波ホーンの先端に、上記基板の上記接合面に対して垂直なねじ穴（１４ｄ）を設け、そのねじ穴に上記半導体チップ保持部材に設けた取付軸部（１５３）のねじ（１５３１）をねじ込み、上記超音波ホーンの先端に上記半導体チップ保持部材を取り外し可能に固定する請求項４に記載の超音波接合装置。

【請求項９】　上記超音波ホーンが、上記半導体チップの上記接合面沿いでかつ上下方向と直交する上記横方向に対して斜め方向に上記超音波振動を上記半導体チップに与えるとともに、

上記超音波ホーンの先端に上下方向沿いに設けられ、かつ、上記基板側の端部に上記半導体チップ保持部材を配置して上記超音波振動を伝達するたわみ振動部（１４１）をさらに備えるようにした請求項４に記載の超音波接合装置。

【請求項１０】　上記超音波ホーンが、上記半導体チップの上記接合面沿いでかつ上下方向と直交する上記横方向に対して斜め方向に上記超音波振動を上記半導体チップに与えるとともに、上記超音波ホーンは、上記超音波振動の縦振動の２個所の節に相当する節部で保持され、上記超音波ホーンの上記超音波振動の縦振動の節と節との間の振動の腹に相当する部分に上下方向沿いに設けられ、かつ、上記基板側の端部に上記半導体チップ保持部材を配置して上記超音波振動を伝達するたわみ振動部（１４１）をさらに備えるようにした請求項４に記載の超音波接合装置。

【請求項１１】　上記超音波ホーンは、上記超音波ホーンの上記超音波振動の縦振動の２個所の節に相当する節部からリブ（１４２，１４３）を一度引き出し、上記リブに対して直角に曲げた取付部（１４４，１４５）を上記加圧装置（１１）に保持するようにした請求項１０に記載の超音波接合装置。

【請求項１２】　上記超音波ホーンは、上記超音波ホーンの上記超音波振動の縦振動の２個所の節に相当する節部において、超音波ホーン１４の両側からそれぞれリブ（１４３１）を横方向に一度引き出し、上記リブから縦振動方向に直角に折り曲げて第１折り曲げ部（１４３２）を形成し、上記第１折り曲げ部から更にその反対方向に直角に折り曲げて第２折り曲げ部（１４３３）を形成し、この第２折り曲げ部にリブ（１４２，１４３）を形成し、該リブに対して直角に曲げた取付部（１４４，１４５）を上記加圧装置（１１）に保持するするようにした請求項１１に記載の超音波接合装置。

【請求項１３】　上記超音波ホーンが、上記半導体チップの上記接合面沿いでかつ上下方向と直交する上記横方向に対して斜め方向に上記超音波振動を上記半導体チッ

プに与えるとともに、
上記超音波ホーンの先端に上下方向沿いに設け、かつ、上記基板側の端部に上記半導体チップ保持部材を配置して上記超音波振動を伝達するたわみ振動部（１４１）を備え、
上記基板の上記接合面に対して垂直な穴（１４１ｂ）を設け、その穴に上記半導体チップ保持部材に設けた取付軸部（１５２）を挿入し、その取付軸部の軸方向に対して垂直に上記たわみ振動部にねじ穴（１４１ｅ）を設け、上記ねじ穴と上記ねじ穴にねじ込む取付ねじ（２６）とで上記たわみ振動部に上記半導体チップ保持部材を取り外し可能に固定するようにした請求項９又は１０に記載の超音波接合装置。
【請求項１４】　上記超音波ホーンが、上記半導体チップの上記接合面沿いでかつ上下方向と直交する上記横方向に対して斜め方向に上記超音波振動を上記半導体チップに与えるとともに、
上記超音波ホーンの先端の上下方向沿いに設け、かつ、上記基板側の端部に上記半導体チップ保持部材を配置して上記超音波振動を伝達するたわみ振動部（１４１）に、割締め穴部（１４６）を設け、その割締め穴に上記半導体チップ保持部材に設けた取付軸部（１５２）を挿入し、その取付軸部の軸方向に垂直に上記割締め穴部にねじ穴（１４６ａ）を設け、上記ねじ穴と上記ねじ穴にねじ込まれる上記半導体チップ保持部材を取付ねじ（２７）とで上記たわみ振動部に上記半導体チップ保持部材を取り外し可能に固定する請求項９又は１０に記載の超音波接合装置。
【請求項１５】　上記超音波ホーンが、上記半導体チップの上記接合面沿いでかつ上下方向と直交する上記横方向に対して斜め方向に上記超音波振動を上記半導体チップに与えるとともに、
上記超音波ホーンの先端に上下方向沿いに設け、かつ、上記基板側の端部に上記半導体チップ保持部材を配置して上記超音波振動を伝達するたわみ振動部（１４１）は、上記基板の上記接合面に対し垂直な穴（１４１１）を設け、その先端に２０°～４０°の屋根型の傾斜面（１４１２）を設けるとともに、
上記半導体チップ保持部材は、その先端の中心部にスリット（１５４３）を設け、上記半導体チップを横方向から保持する構成の上記半導体チップより少し大きめの窪み（１５４１）を設け、その上部に上記たわみ振動部に設けた屋根型の傾斜面の傾斜角度と大略同じ傾斜角度の傾斜面（１５４２）を設け、その上に取付軸部（１５４４）を構成し、
上記たわみ振動部と上記半導体チップ保持部材は、上記加圧装置により加圧されると、上記たわみ振動部と上記半導体チップ保持部材に設けた上記傾斜面同士が互いに当接し合い、かつ、上記スリットを狭めるように上記半導体チップ保持部材が撓むことにより上記半導体チップ保持部材の上記窪みの内面が上記半導体チップを挟み込むように構成され、
上記半導体チップ保持部材は、その取付軸部に設けた切欠部（１５４５）に、その取付軸部（１５４４）の軸方向に対して垂直に上記たわみ振動部に設けたボールプランジャ（２８）が押し当てられ、上記たわみ振動部と一体的に上記半導体チップ保持部材が上方向に引き上げられるように構成されている請求項９又は１０に記載の超音波接合装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、電子部品例えばＩＣチップなどの半導体チップに加圧及び超音波振動を与えて、回路形成体例えば基板に上記半導体チップを接合するフリップチップ実装用超音波接合方法とその装置に関するものである。
【０００２】ここで、回路形成体とは、樹脂基板、紙－フェノール基板、セラミック基板、ガラス・エポキシ（ガラエポ）基板、フィルム基板などの回路基板、単層基板若しくは多層基板などの回路基板、部品、筐体、又は、フレームなど、回路が形成されている対象物を意味する。
【０００３】
【従来の技術】図２４には、従来のフリップチップ実装装置１３０を示している。搬送装置１０２にて搬入されかつＩＣチップが接合されるべき基板（以下、「接合基板」と言う。）１０３は、加熱ステージ１０４に供給され、上記加熱ステージ１０４に基板１０３が保持及び固定され、かつ、図２５に示すように加熱ステージ１０４に接続された加熱制御装置１０７にて制御されながら加熱される。次いで、ウエハーシート１０５から取り出された１個のＩＣチップ１０６は、接合加圧装置１０１に備わる半導体チップ保持部材１１５まで順次受け渡される。
【０００４】図２４～図２６に示すように、このＩＣチップ１０６は、半導体チップ保持部材１１５に吸着固定され、認識動作を経て、接合基板１０３の所定位置に位置決めされる。次いで、ＩＣチップ１０６は、接合加圧装置１０１により、接合基板１０３に対して加圧及び超音波振動を与えられることにより、ＩＣチップ１０６のバンプ１０８と接合基板１０３の電極１０９とが金属接合される。上記接合加圧装置１０１は、ＩＣチップ１０６や接合基板１０３の厚み方向に上記半導体チップ保持部材１１５を移動させるとともにＩＣチップ１０６と接合基板１０３との接合のための加圧を行う加圧装置としてのボイスコイルモータ１１１を有し、上記ボイスコイルモータ１１１の駆動軸１１１ａの先端部分にはブラケット１１２が設けられ、上記ブラケット１１２には超音波ホーン１１４が取付けられている。超音波ホーン１１４の一端部には上記半導体チップ保持部材１１５が取付

けられ、他端部には振動子１１３が取付けられている。上記振動子１１３には、超音波発振器１１７が接続され超音波振動を振動子１１３に発生させる。また、上記ボイスコイルモータ１１１は接合加圧制御装置１１６にて動作制御される。

【０００５】上記超音波ホーン１１４には、その軸方向に沿って割り込みが設けられ、図２５に示すように、半導体チップ保持部材１１５は、半導体チップ保持部材１１５の軸方向に直交方向から上記割り込みにて狭持されている。なお、上述のように半導体チップ保持部材１１５はＩＣチップ１０６を吸着するため、半導体チップ保持部材１１５には吸引用配管１２４が接続されているが、上記吸引用配管１２４はブラケット１１２に支持されていない。また、超音波ホーン１０４は、上記振動子１１３が発する超音波振動の縦振動の節部１４２にあたる任置の位置をブラケット１１２でボルト１２３により割り締め締結されており、上述のように上記ブラケット１１２の上部に設置されているボイスコイルモータ１１１により加圧される。

【０００６】

【発明が解決しようとする課題】しかしながら、上述のような従来の構造では、半導体チップ保持部材１１５の先端がたわみ振動によってほぼ水平方向に振動する為、滑りが発生し、ＩＣチップ１０６に対し振動が上手く伝達されず、ＩＣチップ１０６と接合基板１０３との十分な接合強度が得られなくなり、接合オープン不良を誘発する原因となっている。また、その滑りによって、ＩＣチップ１０６に半導体チップ保持部材１１５による、図２７の（Ａ），（Ｂ）に示すような、たたかれたような傷やクラック１００が発生するという問題がある。

【０００７】更に、上述のように従来の構造では、ボイスコイルモータ１１１による加圧力が大きくなると、超音波ホーン１１４の節部１４２に半導体チップ保持部材１１５からのモーメントが働き、超音波ホーン１１４が上下方向と直交する横方向に傾き、半導体チップ保持部材１１５の先端面と接合基板１０３の接合面との間の平行度が崩れ、ＩＣチップ１０６に対し振動が上手く伝達されないという問題がある。また、超音波ホーン１１４の節部１４２に歪みが発生し、超音波ホーン１１４の共振状態が崩れ、ＩＣチップ１０６に対する振動振幅が安定せず、ＩＣチップ１０６と接合基板１０３との十分な接合強度が得られなくなり、接合オープン不良を誘発する原因となっている。

【０００８】また、従来の構造では、超音波ホーン１１４に、その軸方向に沿って割り込みが設けられ、半導体チップ保持部材１１５は、半導体チップ保持部材１１５の軸方向に直交方向から上記割り込みにて狭持されているため、半導体チップ保持部材１１５のたわみ振動が割り込みによる狭持力の変化によって不安定となり、ＩＣチップ１０６に対する振動振幅が安定せず、ＩＣチップ１０６と接合基板１０３との十分な接合強度が得られなくなり、接合オープン不良を誘発する原因となっている。

【０００９】更にまた、近年、電子機器の軽薄短小化に伴い電子デバイスの小型化が益々求められており、実装技術はワイヤリング方式からフリップチップ方式へと転換期を迎え、大型かつ多ピンＩＣチップでも接合可能となることが大きな課題となっている。

【００１０】このような条件下では、接合加圧力及び超音波パワーの増大が必要となるため、従来の構成のままでは、上記接合オープン不良が激増することは明白である。

【００１１】本発明の目的は、このような問題点を解決するためになされたもので、電子部品と基板との十分な接合強度が得られ、安定した接合を行える、フリップチップ実装用超音波接合方法とその装置を提供することである。

【００１２】

【課題を解決するための手段】上記目的を達成するために、本発明は以下のように構成する。

【００１３】本発明の第１態様によれば、半導体チップを基板上にフリップチップ実装するとき、上記半導体チップのパッド上のバンプと、上記基板の電極と位置合わせし、その後、加圧しながら上記半導体チップに対して上記半導体チップの上記接合面沿いの横方向に対して斜め方向に超音波振動を与えつつ、上記半導体チップの上記パッド上の上記バンプを上記基板の上記電極に接合することを特徴とする超音波接合方法を提供する。

【００１４】本発明の第２態様によれば、上記半導体チップに対する上記半導体チップの上記接合面沿いの横方向に対して斜め方向に上記超音波振動を与える傾斜角度が５度～３５度である第１の態様に記載の超音波接合方法を提供する。

【００１５】本発明の第３態様によれば、第１又は２の態様に記載の超音波接合方法により上記半導体チップが接合された基板を提供する。

【００１６】本発明の第４態様によれば、半導体チップに加圧及び超音波振動を与えて基板に上記半導体チップを接合する超音波接合装置において、上記半導体チップの接合面を上記基板の接合面に対し略平行を保ちつつ保持する半導体チップ保持部材と、上記半導体チップ保持部材に保持された上記半導体チップに、上記半導体チップの上記接合面沿いの横方向に対して斜め方向に上記超音波振動を与える超音波ホーンと、上記超音波ホーンに上記超音波振動を与える振動子と、上記超音波ホーンを保持し、かつ、上記半導体チップ保持部材を介して上記半導体チップに上記基板に対して加圧力を与える加圧装置とを備えることを特徴とする超音波接合装置を提供する。

【００１７】本発明の第５態様によれば、上記半導体チ

ップ保持部材を上記半導体チップに対して上記半導体チップの上記接合面沿いの横方向に対して斜め方向に上記超音波振動を与える上記超音波ホーンの上記超音波振動の傾斜角度が5度～35度である第4の態様に記載の超音波接合装置を提供する。

【0018】本発明の第6態様によれば、上記超音波ホーンの先端に、上記基板の接合面に対して直交する方向に延びる穴を設け、その穴に上記半導体チップ保持部材に設けた取付軸部を挿入し、その取付軸部にねじを設け、そのねじと該ねじにねじ込まれるナットとで上記超音波ホーンの先端に上記半導体チップ保持部材を取り外し可能に固定する第4の態様に記載の超音波接合装置を提供する。

【0019】本発明の第7態様によれば、上記超音波ホーン先端に、上記基板の接合面に対して直交する方向に延びる穴を設け、その穴に上記半導体チップ保持部材に設けた取付軸部を挿入し、その取付軸部に直交するように上記超音波ホーンの先端で延びるねじ穴を設け、上記ねじ穴と該ねじ穴にねじ込まれる取付ねじとで上記超音波ホーンの先端に上記半導体チップ保持部材を取り外し可能に固定する第4の態様に記載の超音波接合装置を提供する。

【0020】本発明の第8態様によれば、上記超音波ホーンの先端に、上記基板の上記接合面に対して垂直なねじ穴を設け、そのねじ穴に上記半導体チップ保持部材に設けた取付軸部のねじをねじ込み、上記超音波ホーンの先端に上記半導体チップ保持部材を取り外し可能に固定する第4の態様に記載の超音波接合装置を提供する。

【0021】本発明の第9態様によれば、上記超音波ホーンが、上記半導体チップの上記接合面沿いでかつ上下方向と直交する上記横方向に対して斜め方向に上記超音波振動を上記半導体チップに与えるとともに、上記超音波ホーンの先端に上下方向沿いに設けられ、かつ、上記基板側の端部に上記半導体チップ保持部材を配置して上記超音波振動を伝達するたわみ振動部をさらに備えるようにした第4の態様に記載の超音波接合装置を提供する。

【0022】本発明の第10態様によれば、上記超音波ホーンが、上記半導体チップの上記接合面沿いでかつ上下方向と直交する上記横方向に対して斜め方向に上記超音波振動を上記半導体チップに与えるとともに、上記超音波ホーンは、上記超音波振動の縦振動の2個所の節に相当する節部で保持され、上記超音波ホーンの上記超音波振動の縦振動の節と節との間の振動の腹に相当する部分に上下方向沿いに設けられ、かつ、上記基板側の端部に上記半導体チップ保持部材を配置して上記超音波振動を伝達するたわみ振動部をさらに備えるようにした第4の態様に記載の超音波接合装置を提供する。

【0023】本発明の第11態様によれば、上記超音波ホーンは、上記超音波ホーンの上記超音波振動の縦振動の2個所の節に相当する節部からリブを一度引き出し、上記リブに対して直角に曲げた取付部を上記加圧装置に保持するようにした第10の態様に記載の超音波接合装置を提供する。

【0024】本発明の第12態様によれば、上記超音波ホーンは、上記超音波ホーンの上記超音波振動の縦振動の2個所の節に相当する節部において、超音波ホーン14の両側からそれぞれリブを横方向に一度引き出し、上記リブから縦振動方向に直角に折り曲げて第1折り曲げ部を形成し、上記第1折り曲げ部から更にその反対方向に直角に折り曲げて第2折り曲げ部を形成し、この第2折り曲げ部にリブを形成し、該リブに対して直角に曲げた取付部を上記加圧装置に保持するするようにした第11の態様に記載の超音波接合装置を提供する。

【0025】本発明の第13態様によれば、上記超音波ホーンが、上記半導体チップの上記接合面沿いでかつ上下方向と直交する上記横方向に対して斜め方向に上記超音波振動を上記半導体チップに与えるとともに、上記超音波ホーンの先端に上下方向沿いに設け、かつ、上記基板側の端部に上記半導体チップ保持部材を配置して上記超音波振動を伝達するたわみ振動部を備え、上記基板の上記接合面に対して垂直な穴を設け、その穴に上記半導体チップ保持部材に設けた取付軸部を挿入し、その取付軸部の軸方向に対して垂直に上記たわみ振動部にねじ穴を設け、上記ねじ穴と上記ねじ穴にねじ込む取付ねじとで上記たわみ振動部に上記半導体チップ保持部材を取り外し可能に固定するようにした第9又は10の態様に記載の超音波接合装置を提供する。

【0026】本発明の第14態様によれば、上記超音波ホーンが、上記半導体チップの上記接合面沿いでかつ上下方向と直交する上記横方向に対して斜め方向に上記超音波振動を上記半導体チップに与えるとともに、上記超音波ホーンの先端の上下方向沿いに設け、かつ、上記基板側の端部に上記半導体チップ保持部材を配置して上記超音波振動を伝達するたわみ振動部に、割締め穴部を設け、その割締め穴に上記半導体チップ保持部材に設けた取付軸部を挿入し、その取付軸部の軸方向に垂直に上記割締め穴部にねじ穴を設け、上記ねじ穴と上記ねじ穴にねじ込まれる上記半導体チップ保持部材を取付ねじとで上記たわみ振動部に上記半導体チップ保持部材を取り外し可能に固定する第9又は10の態様に記載の超音波接合装置を提供する。

【0027】本発明の第15態様によれば、上記超音波ホーンが、上記半導体チップの上記接合面沿いでかつ上下方向と直交する上記横方向に対して斜め方向に上記超音波振動を上記半導体チップに与えるとともに、上記超音波ホーンの先端に上下方向沿いに設け、かつ、上記基板側の端部に上記半導体チップ保持部材を配置して上記超音波振動を伝達するたわみ振動部は、上記基板の上記接合面に対し垂直な穴を設け、その先端に20°～40

°の屋根型の傾斜面を設けるとともに、上記半導体チップ保持部材は、その先端の中心部にスリットを設け、上記半導体チップを横方向から保持する構成の上記半導体チップより少し大きめの窪みを設け、その上部に上記たわみ振動部に設けた屋根型の傾斜面の傾斜角度と大略同じ傾斜角度の傾斜面を設け、その上に取付軸部を構成し、上記たわみ振動部と上記半導体チップ保持部材は、上記加圧装置により加圧されると、上記たわみ振動部と上記半導体チップ保持部材に設けた上記傾斜面同士が互いに当接し合い、かつ、上記スリットを狭めるように上記半導体チップ保持部材が撓むことにより上記半導体チップ保持部材の上記窪みの内面が上記半導体チップを挟み込むように構成され、上記半導体チップ保持部材は、その取付軸部に設けた切欠部に、その取付軸部の軸方向に対して垂直に上記たわみ振動部に設けたボールプランジャが押し当てられ、上記たわみ振動部と一体的に上記半導体チップ保持部材が上方向に引き上げられるように構成されている第９又は１０の態様に記載の超音波接合装置を提供する。

【００２８】

【発明の実施の形態】以下に、本発明にかかる実施の形態を図面に基づいて詳細に説明する。

【００２９】（第１実施形態）図１～図３及び図１１～図１２に、本発明の第１実施形態にかかる超音波接合方法を実施することができるフリップチップ実装用超音波接合装置を示す。

【００３０】図１１には、上記フリップチップ実装用超音波接合装置１を備えるフリップチップ実装装置３０の全体を示している。搬送装置２Ａにて搬入されかつ半導体チップの一例としてのＩＣチップ６が接合されるべき基板（以下、「接合基板」と言う。）３は、加熱ステージ４に供給され、上記加熱ステージ４に基板３が保持及び固定され、かつ、図１２に示すように加熱ステージ４に接続された加熱制御装置７にて制御されながら加熱される。次いで、ウエハーシート５からＩＣチップ取出装置１Ａにより吸着して取り出された１個のＩＣチップ６は、接合加圧装置１に備わる半導体チップ保持部材１５に順次受け渡される。次いで、図１１～図１２に示すように、このＩＣチップ６は、半導体チップ保持部材５に吸着固定され、認識動作を経て、接合基板３の所定位置に位置決めされる。次いで、ＩＣチップ６は、上記フリップチップ実装用超音波接合装置１により、接合基板３に対して加圧及び超音波振動を与えられることにより、ＩＣチップ６のパッド６ａ上に予め形成された各バンプ８と接合基板３の各電極９とが金属接合される。上記接合加圧装置１は、ＩＣチップ６や接合基板３の厚み方向に上記半導体チップ保持部材５を移動させるとともにＩＣチップ６と接合基板３との接合のための加圧を行う。次いで、ＩＣチップ６が接合された接合基板３が搬送装置２Ｂにて搬出される。

【００３１】上記フリップチップ実装用超音波接合装置１は、ＩＣチップ６に加圧及び超音波振動を与えて、ＩＣチップ６が接合されるべき基板（以下、「接合基板」と言う。）３に上記ＩＣチップ６を直接接合する超音波接合装置であって、上記ＩＣチップ６の接合面を上記基板３の接合面に対し略平行を保ちつつ保持する半導体チップ保持部材１５と、上記半導体チップ保持部材１５に保持された上記ＩＣチップ６に、上記半導体チップの上記接合面沿いの横方向であって例えば上下方向と直交する横方向に対して、斜め方向に上記超音波振動を与える超音波ホーン１４と、上記超音波ホーン１４に上記超音波振動を与える振動子１３と、上記超音波ホーン１４を保持し、かつ、上記半導体チップ保持部材１５を介して上記ＩＣチップ６に上記基板３に対して接合のための加圧力を与える加圧装置の一例としてのボイスコイルモータ１１とを備える。

【００３２】上記ボイスコイルモータ１１は、加圧力１１１を発生するものであり、図１２に示すように接合加圧制御装置１６にて動作制御される。図１２において上記ボイスコイルモータ１１の駆動軸１１ａの下端部分には、大略逆Ｌ字状のブラケット１２が設けられ、上記ブラケット１２には、後述するように、上記超音波ホーン１４が、その長手軸方向が上下方向と直交する横方向に対して５°～３５°傾斜した傾斜角度を持って取付けられている。上記傾斜角度をこのような範囲にする理由は、上記傾斜角度が５°未満であれば、ＩＣチップにクラックが発生する可能性があり、上記傾斜角度が３５°を越えるとＩＣチップにクラックが発生する可能性があるためである。上記傾斜角度は、ＩＣチップ接合強度の観点から、好ましくは、１５°である。

【００３３】この超音波ホーン１４の傾斜角度と、接合品質及び超音波特性との関係を表１に示す。

【００３４】

【表１】

超音波ホーン 傾斜角度 / 項目	0°	5°	10°	15°	20°	30°	45°
ICチップ接合強度	○	○	◎	◎	◎	○	−
ICチップのクラック	×	△	◎	◎	◎	△	−
超音波振動特性	◎	○	○	○	○	△	×
総合評価	△	△	○	◎	○	×	×

【００３５】上記表１において、ＩＣチップ接合強度、超音波振動特性、及び、総合評価における、◎は優良、○は良好、△は普通、×は悪い、－は測定せずを示す。ＩＣチップのクラックにおける、◎はクラックは全く無し、△はクラック発生率３％未満、×はクラック発生率３％以上、－は測定せず、である。

【００３６】評価条件としては、各バンプはＡｕからなり、スタッドバンプボンディングにより形成された５０バンプ／ＩＣチップ、すなわち、１個のＩＣチップにつき５０個のバンプを有しているものてを使用する。ＩＣチップの材質はＳｉ（シリコン）であり、基板材質はセラミックでかつＡｕ電極とする。また、接合時加圧力は４０Ｎであり、超音波周波数は６３ｋＨｚとする。

【００３７】この表の結果より、上記角度範囲が好ましいことがわかる。

【００３８】一方、上記超音波ホーン１４の長手軸方向の一端部には上記半導体チップ保持部材１５が取付けられ、その長手軸方向の他端部には上記振動子１３が取付けられている。上記振動子１３には、図１２に示すように超音波発振器１７が接続され、超音波発振器１７により振動子１３に超音波振動を発生させるようにしている。

【００３９】また、超音波ホーン１４は、上記振動子１３が発する超音波振動の縦振動の節部にあたる任置の位置でブラケット１２にボルト２５により割り締め締結されている。すなわち、図４に示すように、超音波ホーン４の、上記振動子１３が発する超音波振動の縦振動の節部にあたる任置の位置に両側に延びた一対の取付けフランジ１４ａ，１４ａを張り出すように超音波ホーン４に形成し、この各取付けフランジ１４ａをブラケット１２の二股に分かれた取付板１２ａにボルト２５によりそれぞれ締結することにより、超音波ホーン４の長手軸方向が上下方向と直交する横方向に対して５°～３５°傾斜した傾斜角度を持ってブラケット１２に取付けられている。

【００４０】上記超音波ホーン１４の長手軸方向の一端部に、上記半導体チップ保持部材１５が以下のようにして取付けられている。すなわち、超音波ホーン１４は、その長手軸方向の一端部に、上下方向と直交する横方向に沿いの下端面１４ｂを有し、この下端面１４ｂに、上記半導体チップ保持部材１５を固定する方法の一例としては、図３に示すように、上記半導体チップ保持部材１５が、ねじ１５１１が切られた取付軸部１５１０を有して、超音波ホーン１４の長手軸方向の上記一端部の下端面１４ｂから上方に向けて、上記半導体チップ保持部材１５の取付軸部１５１０を超音波ホーン１４の貫通穴１４ｃに貫通させて、超音波ホーン１４から上方に突出した取付軸部１５１０のねじ１５１１にナット２５１がねじ込まれることにより、超音波ホーン１４の長手軸方向の上記一端部の下端面１４ｂに上記半導体チップ保持部材１５が取り外し可能に締結固定されている。

【００４１】上記半導体チップ保持部材１５は、ＩＣチップ６を吸着するため、半導体チップ保持部材１５の下端面に形成された多数の貫通孔には吸引用配管２４が接続され、半導体チップ保持部材１５の下端面に形成された多数の貫通孔を通じての吸引動作により半導体チップ保持部材１５の下端面にＩＣチップ６を吸着できるようにしている。上記吸引用配管２４は、ブラケット１２に支持されている。このように、図１、図２に示すように、ＩＣチップ６は、一例として、吸引用配管２４を通じて吸引される半導体チップ保持部材１５に吸着固定されているが、ＩＣチップ６は、半導体チップ保持部材１５に対して、吸着の代わりに磁力により保持されるようにしてもよい。上記半導体チップ保持部材１５の下端面は、ＩＣチップ６の材質との相性の良いものが好ましい。例えば、ＩＣチップ６の材質がシリコンの場合には上記下端面はＳＵＳ（ステンレス鋼）より構成し、ＩＣチップ６の材質がガリウム－砒素などの化合物半導体の場合には上記下端面は超鋼材料より構成するのが好ましい。

【００４２】接合基板３は、加熱ステージ４上に吸着などにより固定される。

【００４３】以下に、上記フリップチップ実装用の超音波接合装置を用いた超音波接合方法を説明する。

【００４４】ＩＣチップ６は、半導体チップ保持部材１５の下端面に吸引用配管２４を通じて吸着固定され、半導体チップ保持部材１５に保持されたＩＣチップ６が、図示しない認識動作により保持姿勢が認識された後、認識結果に基き姿勢角度を補正しつつ、加熱ステージ４上に固定されかつ加熱された接合基板３の接合すべき位置に位置決めされる。

【００４５】次いで、上記フリップチップ実装用超音波

接合装置１により、ＩＣチップ６及び接合基板３の厚み方向に、ＩＣチップ６を保持した上記半導体チップ保持部材１５を接合加圧制御装置１６の制御の下に移動させるとともに、ボイスコイルモータ１１と接合加圧制御装置１６にて接合加圧動作制御され、ＩＣチップ６と接合基板３との接合のための加圧押し込みが行われる。これと同時に、ボイスコイルモータ１１の先に付いたブラケット１２に取付けられた超音波ホーン１４の振動子１３に超音波発振器１７より超音波振動信号が送られ、振動子１３で発生した振動を超音波ホーン１４で増幅し、上下方向と直交する横方向に対して５°～３５°の傾斜角度を持って超音波振動２０が半導体チップ保持部材１５に与えられる。この超音波振動２０が、超音波ホーン１４及び半導体チップ保持部材１５を介して、半導体チップ保持部材１５に保持されたＩＣチップ６に摩擦伝達され、ＩＣチップ６が接合基板３上で、超音波ホーン１４の超音波振動２０と同じ方向の超音波振動２１で振動し、ＩＣチップ６の各バンプ８と接合基板３の各電極９とが金属接合される結果、ＩＣチップ６が接合基板３に接合される。

【００４６】なお、ＩＣチップ６を吸着しかつ半導体チップ保持部材１５の下端面を構成する部材で取り外し可能なコレット１５ａの材質及び表面粗さについては、図８に示すように、半導体チップ保持部材１５のコレット１５ａの材質及び表面粗さは、接合対象であるＩＣチップ６の材質、表面粗さに左右され、最も摩擦係数が高くなる組み合わせが望ましい。例えば、ＩＣチップ６がシリコンＩＣチップであれば、コレット１５ａをＳＵＳ材でかつ表面粗さが０．１μｍ以下とすれば、摩擦係数も高く、振動も伝達し易い。なお、第１実施形態の場合、Ｚ方向の振動成分があることで、Ｚ振動の少ない従来方式から比べると、上記摩擦係数の影響は小さくなる。

【００４７】上記第１実施形態によれば、半導体チップ保持部材１５の先端が、加圧しながら、ＩＣチップ６に、上下方向と直交する横方向に対して斜め方向（上下方向と直交する横方向に対して例えば５°～３５°傾斜した方向）に超音波振動を伝達するため、ＩＣチップ６が半導体チップ保持部材１５に対して同じ振動挙動をし、超音波振動が安定してＩＣチップ６に伝達される。これにより、ＩＣチップ６と接合基板３との十分な接合強度が得られ、接合信頼性が向上する。この接合信頼性に関して、従来との比較を図５に示す。すなわち、図５は、ＩＣチップ６内のバンプ８の個数と接合不良（言い換えれば、接合強度が弱い）の割合との関係を示す図である。図５の横軸は第１実施形態と従来の超音波接合方法のそれぞれによるＩＣチップの接合を行うとき、バンプ８の個数が、ＩＣチップ１個あたり１０個、ＩＣチップ１個あたり３０個、ＩＣチップ１個あたり５０個、ＩＣチップ１個あたり１００個の場合を示し、縦軸はそれぞれの場合での接合不良の割合をパーセンテージで示す。

【００４８】また、ＩＣチップ６が半導体チップ保持部材１５に対して同じ振動挙動をするため、半導体チップ保持部材１５によるＩＣチップ６へのダメージが無い。

【００４９】また、第１実施形態によれば、上下方向と直交する横方向に対して斜め方向の超音波振動によりＩＣチップ６を基板３に接合するため、図６に示すように、超音波振動が上下方向すなわちＺ方向の成分を有することになり、図７に示すように短時間で接合が完了する。なお、図７の横軸は上記第１実施形態と従来のフリップチップ実装用の超音波接合方法を示し、縦軸は接合時間を示す。

【００５０】また、第１実施形態によれば、半導体チップ保持部材１５を超音波ホーン１４の長手軸方向の一端部にボルトとナットとの結合により取付けることができるため、ボルトとナットとの結合を緩めることにより、半導体チップ保持部材１５と取付軸部１５１０との取付角度が異なる半導体チップ保持部材１５、又は、超音波ホーン１４の下端面１４ｂに対して傾斜した下端面を有する半導体チップ保持部材１５に容易に交換することができて、超音波ホーン１４に対する半導体チップ保持部材１５の取付角度が容易に調整できる。

【００５１】また、第１実施形態によれば、半導体チップ保持部材１５を超音波ホーン１４の長手軸方向の一端部に、半導体チップ保持部材１５の取付軸部１５１０のねじ１５１１にナット２５１がねじ込まれることにより取り外し可能に取付けることができるため、超音波ホーン１４の前上方より半導体チップ保持部材１５を強固にかつ取り外し可能に固定でき、半導体チップ保持部材１５が摩耗しても、ねじ１５１１とナット２５１との結合を緩めることにより、簡単に部材交換することができる。

【００５２】なお、図９には、上記第１実施形態のフリップチップ実装用の超音波接合方法における超音波振動と上下方向の加圧力Ｆ｛＝（ＩＣチップ１個あたりのバンプ個数）×０．８Ｎ｝との関係を示し、図１０には、上記第１実施形態のフリップチップ実装用の超音波接合方法における超音波振動と上下方向の加圧力との関係をグラフで示す。ＩＣチップ６と基板３との間の接合後の接合高さｈを確保するための接合条件を図１０に示す。図１０より接合条件として、高い接合強度を得るためには、適正な超音波パワーと加圧力のバランスがあり、どちらかが強過ぎても、弱過ぎても、得られる接合強度は弱くなってしまうことがわかる。

【００５３】（第２実施形態）本発明の第２実施形態にかかるフリップチップ実装用超音波接合方法とその装置は、第１実施形態とは異なる方法で、超音波ホーン１４の長手軸方向の上記一端部の下端面１４ｂに、上記半導体チップ保持部材１５を固定するものである。すなわち、図１３に示すように、上記半導体チップ保持部材１

５が、取付軸部１５２を有して、超音波ホーン１４の長手軸方向の上記一端部の下端面１４ｂから上方に向けて、上記半導体チップ保持部材１５の取付軸部１５２を超音波ホーン１４の貫通穴１４ｃに貫通させて、超音波ホーン１４の上記一端部からねじ穴１４ｅ内に上記取付軸部１５２の長手軸方向と直交する方向に取付ボルト２６をねじ込み、取付ボルト２６の先端を取付軸部１５２に接触させて超音波ホーン１４から上記半導体チップ保持部材１５の取付軸部１５２が抜け落ちないように固定している。

【００５４】このような構造にすれば、上記半導体チップ保持部材１５の取付軸部１５２に取付ボルト２６をねじ込むことにより超音波ホーン１４に上記半導体チップ保持部材１５を簡単に取付けることができるため、取付ボルト２６を緩めることにより、半導体チップ保持部材１５と取付軸部１５１０との取付角度が異なる半導体チップ保持部材１５、又は、超音波ホーン１４の下端面１４ｂに対して傾斜した下端面を有する半導体チップ保持部材１５に容易に交換することができて、超音波ホーン１４に対する半導体チップ保持部材１５の取付角度が容易に調整できる。また、第２実施形態によれば、半導体チップ保持部材１５を超音波ホーン１４の長手軸方向の一端部に、半導体チップ保持部材１５の取付軸部１５２に向けて超音波ホーン１４に取付ボルト２６がねじ込まれて係止されることにより、取り外し可能に取付けることができるため、取付ボルト２６を緩めることにより、超音波ホーン１４の前方より半導体チップ保持部材１５を強固にかつ取り外し可能に固定でき、半導体チップ保持部材１５が摩耗しても簡単に部材交換することができる。

【００５５】（第３実施形態）本発明の第３実施形態にかかるフリップチップ実装用超音波接合方法を実施することができるフリップチップ実装用超音波接合装置は、第１実施形態及び第２実施形態とは異なる方法で、超音波ホーン１４の長手軸方向の上記一端部の下端面１４ｂに、上記半導体チップ保持部材１５を固定するものである。すなわち、図１４に示すように、超音波ホーン１４の長手軸方向の上記一端部に接合基板３に対して直交する方向、言い換えれば、上下方向沿いにねじ穴１４ｄが切られ、上記円形の半導体チップ保持部材１５の取付軸１５３に設けられたねじ１５３１を上記ねじ穴１４ｄにねじ込み、取り外し可能に上記半導体チップ保持部材１５を超音波ホーン１４に締結固定するようにしたものである。

【００５６】このような構造によれば、超音波ホーン１４の下方より上向きに半導体チップ保持部材１５の取付軸１５３のねじ１５３１を、超音波ホーン１４の長手軸方向の上記一端部の下端面１４ｂの上記ねじ穴１４ｄにねじ込むことにより、半導体チップ保持部材１５を超音波ホーン１４に容易にかつ強固にかつ取り外し可能に締結固定できる。従って、半導体チップ保持部材１５が摩耗しても、ねじ穴１４ｄに対して半導体チップ保持部材１５の取付軸１５３のねじ１５３１を緩めることにより、上記半導体チップ保持部材１５を超音波ホーン１４から容易に取り外すことができて、半導体チップ保持部材１５の部材交換が容易にできる。

【００５７】（第４実施形態）図１５に、本発明の第４実施形態にかかるフリップチップ実装用超音波接合方法を実施することができるフリップチップ実装用超音波接合装置を示す。この第４実施形態は、超音波ホーン１４の長手軸方向の一端部に、超音波ホーン１４に半導体チップ保持部材１５を直接固定する代りに、超音波ホーン１４からの超音波振動により上下方向と直交する横方向にたわみ振動を発生させるたわみ振動部１４１を介して超音波ホーン１４に半導体チップ保持部材１５を配置し、そのたわみ振動部１４１の下端部に半導体チップ保持部材１５を配置している点で上記第１～第３実施形態とは異なるものである。

【００５８】すなわち、図１５に示すように、ＩＣチップ６は、半導体チップ保持部材１５に吸着固定されている。接合基板３は加熱ステージ４上に固定され、接合基板３上には電子部品１０が搭載されている。ボイスコイルモータ１１は、加圧力５１を発生する加圧装置の一例であり、上記ボイスコイルモータ１１の駆動軸１１ａの先端部分にはブラケット１２が設けられ、上記ブラケット１２には超音波ホーン１４が、上下方向と直交する横方向に5°～３５°傾斜角度を持って取付けられている。上記超音波ホーン１４の長手軸方向の一端部の端面には、半導体チップ保持部材１５の代りに、上下方向と直交する横方向にたわみ振動を発生させる、たわみ振動部１４１の中間部が固定されている。たわみ振動部１４１の下端部の貫通穴１４１ｂには、図１６に示すように、半導体チップ保持部材１５の取付軸部１５２が挿入され、その取付軸部１５２の軸方向と直交する方向から、取付ボルト２６をたわみ振動部１４１のねじ穴１４１ｅ内にねじ込み、取付ボルト２６の先端を取付軸部１５２に接触させてたわみ振動部１４１から上記半導体チップ保持部材１５の取付軸部１５２が抜け落ちないように固定している。なお、たわみ振動部１４１には、上記半導体チップ保持部材１５の取付軸部１５２の吸引孔１５ｂに連通する貫通穴１４１ｂにさらに連通する吸引通路１４１ａを備えて、吸引通路１４１ａが吸引用配管２４に連結されている。

【００５９】また、超音波ホーン１４の長手軸方向の他端部には、第１～第４実施形態と同様に、振動子１３が取付けられている。上記振動子１３には、超音波発振器１７が接続され超音波振動を振動子１３に発生させる。また、上記ボイスコイルモータ１１は、第１～第４実施形態と同様に、接合加圧制御装置１６にて動作制御される。

【００６０】第１～第４実施形態と同様に、半導体チップ保持部材１５はＩＣチップ６を吸着するため、半導体チップ保持部材１５には吸引用配管２４が接続され、上記吸引用配管２４はブラケット１２に支持される。超音波ホーン１４は、上記振動子１３が発する超音波振動の縦振動の節部にあたる任置の位置に両側に延びた一対の取付けフランジ１４ａ，１４ａを張り出すように形成し、この各取付けフランジ１４ａをブラケット１２の二股に分かれた取付板１２ａにボルト２５によりそれぞれ締結することにより、超音波ホーン４の長手軸方向が上下方向と直交する横方向に対して５°～３５°傾斜した傾斜角度を持ってブラケット１２に締結固定される。

【００６１】以下に、上記フリップチップ実装用の超音波接合装置を用いた超音波接合方法を説明する。

【００６２】まず、ＩＣチップ６は、半導体チップ保持部材１５に吸引用配管２４を通じて吸着固定され、認識動作を経て、接合基板３の所定位置に電子部品１０を避けて位置決めされる。

【００６３】次いで、ＩＣチップ６は、上記フリップチップ実装用超音波接合装置１により、ＩＣチップ６や接合基板３の厚み方向に上記半導体チップ保持部材１５を移動させるとともに、ボイスコイルモータ１１と接合加圧制御装置１６にて動作制御され、ＩＣチップ６と接合基板３との接合のための加圧押し込みが行われる。これと同時に、ボイスコイルモータ１１の先に付いたブラケット１２に取付けられた超音波ホーン１４の振動子１３に超音波発振器１７より超音波振動信号が送られ、振動子１３から発生した縦振動を超音波ホーン１４で増幅し、更に超音波ホーン１４の先端に上下方向沿いに設けられた上記たわみ振動部１４１に、上下方向と直交する横方向に対して５°～３５°の傾斜角度を持って超音波振動が与えられる。この超音波振動が、上記たわみ振動部１４１及び上記半導体チップ保持部材１５を介してＩＣチップ６に摩擦伝達され、ＩＣチップ６の各バンプ８と接合基板３の各電極９とが金属接合される。上記傾斜角度としては、上記第１実施形態と同様な理由で上記範囲が選択される。

【００６４】この第４実施形態によれば、半導体チップ保持部材１５の先端が、加圧しながらＩＣチップ６に対して上下方向と直交する横方向に対して斜め方向（例えば５°～３５°方向）に超音波振動するため、ＩＣチップ６が半導体チップ保持部材１５に対して同じ振動挙動をし、超音波振動が安定してＩＣチップ６に伝達される。これにより、ＩＣチップ６と接合基板３との十分な接合強度が得られ、接合信頼性が向上する。また、ＩＣチップ６が半導体チップ保持部材１５に対して同じ振動挙動をするため、半導体チップ保持部材１５によるＩＣチップ６へのダメージが無い。

【００６５】さらに、第４実施形態によれば、電子部品１０のような障害物があっても、超音波ホーン１４に半導体チップ保持部材１５が直接固定されているのではなく、超音波ホーン１４に上下方向沿いに延びた上記たわみ振動部１４１により半導体チップ保持部材１５を支持しているため、超音波ホーン１４が電子部品１０に接触せずに、たわみ振動部１４１が電子部品１０を避けてＩＣチップ６を接合基板３に対して位置決めすることができるため、電子部品１０のような障害物がある場合にも、ＩＣチップ６の接合を確実に行うことができる。

【００６６】また、第４実施形態によれば、超音波ホーン１４のたわみ振動部１４１の下端部の貫通穴１４１ｂに半導体チップ保持部材１５の取付軸部１５２を下方より上向きに挿入し、取付軸部１５２の軸方向と直交する方向から、取付ボルト２６の先端を取付軸部１５２に接触させてたわみ振動部１４１から上記半導体チップ保持部材１５の取付軸部１５２が抜け落ちないように固定しているため、取付ボルト２６を緩めることにより、半導体チップ保持部材１５と取付軸部１５２との取付角度が異なる半導体チップ保持部材１５、又は、たわみ振動部１４１の下端面に対して傾斜した下端面を有する半導体チップ保持部材１５に容易に交換することができて、たわみ振動部１４１に対する半導体チップ保持部材１５の取付角度が容易に調整できるとともに、半導体チップ保持部材１５が摩耗したときにも、交換が容易である。

【００６７】（第５実施形態）図１７～図１９に、本発明の第５実施形態にかかるフリップチップ実装用超音波接合方法を実施することができるフリップチップ実装用超音波接合装置を示す。上記第５実施形態は、超音波ホーン１４の先端にたわみ振動部１４１を介して半導体チップ保持部材１５を配置する代りに、超音波ホーン１４の中間部にたわみ振動部１４１を介して半導体チップ保持部材１５を配置するようにしている点で、上記第４実施形態と異なる。

【００６８】すなわち、図１７に示すように、ＩＣチップ６は、半導体チップ保持部材１５に吸着固定されている。接合基板３は加熱ステージ４上に固定され、接合基板３上には電子部品１０が搭載されている。ボイスコイルモータ１１は、加圧力５１を発生する加圧装置の一例であり、上記ボイスコイルモータ１１の駆動軸１１ａの先端部分にはブラケット１２が設けられ、上記ブラケット１２には超音波ホーン１４が取付けられている。この超音波ホーン１４は、超音波ホーンの縦振動の節にそれぞれ相当する節部と節部の２個所で横方向両側にそれぞれ突出し、突出した上記節部と節部からリブ１４２，１４３を一度引き出し、上下方向と直交する横方向に対して５°～３５°の傾斜角度を持ち、図１７及び図１８に示すように、上記リブに対して直角に曲げたすなわち縦振動方向に曲げた取付部１４４，１４５が設けられ、上記ブラケット１２に対して取付部１４４，１４５がボルト２５によりそれぞれ締結保持される。上記２個の節部のそれぞれと超音波ホーン１４の結合部は、詳しくは以

下のような構造としている。すなわち、図１９に代表的にリブ１４３側の節部で示すように、リブ１４３側の節部において超音波ホーン１４の両側からそれぞれリブ１４３１を横方向に一度引き出し、上記リブ１４３１から縦振動方向に直角に折り曲げて第１第１折り曲げ部１４３２を形成し、第１折り曲げ部１４３２から更にその反対方向に直角に折り曲げて第２折り曲げ部１４３３を形成し、この第２折り曲げ部１４３３にリブ１４２，１４３を形成し、該リブ１４２，１４３に対して直角に曲げた取付部１４４，１４５を上記加圧装置１１に保持するように結合する構成としている。上記リブ１４２側の節部も同様の構成としている。

【００６９】また、上記節部と節部との間の超音波振動の腹の部分には、上下にたわみ振動部１４１が設けられている。上記たわみ振動部１４１の下端部の貫通穴１４１ｂには、第４実施形態と同様に図１６に示すように、半導体チップ保持部材１５２の取付軸部１５２が挿入され、その取付軸部１５２の軸方向と直交する方向から、取付ボルト２６をたわみ振動部１４１のねじ穴１４１ｅ内にねじ込み、取付ボルト２６の先端を取付軸部１５２に接触させてたわみ振動部１４１から上記半導体チップ保持部材１５の取付軸部１５２が抜け落ちないように固定している。超音波ホーン１４の他端部には、第１～第４実施形態と同様に、振動子１３が取付けられている。上記振動子１３には、超音波発振器１７が接続され超音波振動を振動子１３に発生させる。また、上記ボイスコイルモータ１１は、第１～第４実施形態と同様に、接合加圧制御装置１６にて動作制御される。

【００７０】第１～第４実施形態と同様に、半導体チップ保持部材１５はＩＣチップ６を吸着するため、半導体チップ保持部材１５には吸引用配管２４が接続され、上記吸引用配管２４はブラケット１２に支持される。

【００７１】以下に、上記フリップチップ実装用の超音波接合装置を用いた超音波接合方法を説明する。

【００７２】まず、ＩＣチップ６は、半導体チップ保持部材１５に吸引用配管２４を通じて吸着固定され、認識動作を経て、接合基板３の所定位置に電子部品１０を避けて位置決めされる。

【００７３】次いで、ＩＣチップ６は、上記フリップチップ実装用超音波接合装置１により、ＩＣチップ６や接合基板３の厚み方向に上記半導体チップ保持部材１５を移動させるとともに、ボイスコイルモータ１１と接合加圧制御装置１６にて動作制御され、ＩＣチップ６と接合基板３との接合のための加圧押し込みが行われる。これと同時に、ボイスコイルモータ１１の先に付いたブラケット１２に取付けられた超音波ホーン１４の振動子１３に超音波発振器１７より超音波振動信号が送られ、振動子１３から発生した縦振動を超音波ホーン１４で増幅し、更に超音波ホーン１４の上記節部と節部の間の超音波振動の腹に相当する部分に上下方向沿いに設けられた上記たわみ振動部１４１に、上下方向と直交する横方向に対して５°～３５°傾斜角度を持って超音波振動が与えられる。この超音波振動が、上記たわみ振動部１４１及び上記半導体チップ保持部材１５を介してＩＣチップ６に摩擦伝達され、ＩＣチップ６の各バンプ８と接合基板３の各電極９とが金属接合される。

【００７４】この第５実施形態によれば、半導体チップ保持部材１５の先端が、加圧しながらＩＣチップ６に対して上下方向と直交する横方向に対して斜め方向（例えば５°～３５°方向）に超音波振動するため、ＩＣチップ６が半導体チップ保持部材１５に対して同じ振動挙動をし、超音波振動が安定してＩＣチップ６に伝達される。これにより、ＩＣチップ６と接合基板３との十分な接合強度が得られ、接合信頼性が向上する。また、ＩＣチップ６が半導体チップ保持部材１５に対して同じ振動挙動をするため、半導体チップ保持部材１５によるＩＣチップ６へのダメージが無い。

【００７５】さらに、第５実施形態によれば、電子部品１０のような障害物があっても、超音波ホーン１４に半導体チップ保持部材１５が直接固定されているのではなく、超音波ホーン１４に上下方向沿いに延びた上記たわみ振動部１４１により半導体チップ保持部材１５を支持しているため、超音波ホーン１４が電子部品１０に接触せずに、たわみ振動部１４１が電子部品１０を避けてＩＣチップ６を接合基板３に対して位置決めすることができるため、電子部品１０のような障害物がある場合にも、ＩＣチップ６の接合を確実に行うことができる。

【００７６】また、第５実施形態によれば、ボイスコイルモータ１１による加圧力５１が大きくなっても、超音波ホーン１４の節部と節部による、加圧力５１に対する両持ち構造であるため、半導体チップ保持部材１５の下端面であるＩＣチップ保持面と接合基板３の接合面との間の平行度が崩れることなく、ＩＣチップ６に対して超音波振動が安定して伝達することができる。また、超音波ホーン１４の取付面１２ａに加圧負荷等により歪みが発生しても、上記取付部１４２，１４３を有するリブ構造が弾性変形してその歪みを吸収する為、超音波ホーン１４が歪むことなく安定した共振状態を維持でき、ＩＣチップ６と接合基板３との十分な接合強度が得られ、接合信頼性が向上する。

【００７７】また、第５実施形態によれば、超音波ホーン１４のたわみ振動部１４１の下端部の貫通穴１４１ｂに半導体チップ保持部材１５の取付軸部１５２を下方より上向きに挿入し、取付軸部１５２の軸方向と直交する方向から、取付ボルト２６の先端を取付軸部１５２に接触させてたわみ振動部１４１から上記半導体チップ保持部材１５の取付軸部１５２が抜け落ちないように固定しているため、取付ボルト２６を緩めることにより、半導体チップ保持部材１５と取付軸部１５２との取付角度が異なる半導体チップ保持部材１５、又は、たわみ振動部

141の下端面に対して傾斜した下端面を有する半導体チップ保持部材15に容易に交換することができて、たわみ振動部141に対する半導体チップ保持部材15の取付角度が容易に調整できるとともに、半導体チップ保持部材15が摩耗したときにも、交換が容易である。

【0078】（第6実施形態）本発明の第6実施形態にかかるフリップチップ実装用超音波接合方法を実施することができるフリップチップ実装用超音波接合装置は、たわみ振動部141の下端部での半導体チップ保持部材15の保持構造が第4，5実施形態と異なるものである。すなわち、たわみ振動部141の下端部での半導体チップ保持部材15の保持構造が、図20に示すように、たわみ振動部141に、割締め穴部146を設け、その割締め穴部146に上記半導体チップ保持部材15に設けた取付軸部152を挿入し、その取付軸部152の軸方向に垂直に上記割締め穴146にねじ穴146aを設け、ねじ穴146aに取付ボルト27をねじ込むことにより、上記割締め穴146の内面で上記半導体チップ保持部材15の取付軸部152を把持して上記半導体チップ保持部材15を上記たわみ振動部141に締結固定するようにしている。

【0079】このような第6実施形態によれば、超音波ホーン14のたわみ振動部141の下端部の割締め穴146内に半導体チップ保持部材15の取付軸部152を下方より上向きに挿入し、割締め穴146の軸方向とは垂直に形成されたねじ穴146aに取付ボルト27をねじ込むことにより、上記割締め穴146の内面で上記半導体チップ保持部材15の取付軸部152を把持して上記半導体チップ保持部材15を上記たわみ振動部141に締結固定するようにしている。このため、取付ボルト27を緩めることにより、半導体チップ保持部材15と取付軸部152との取付角度が異なる半導体チップ保持部材15、又は、たわみ振動部141の下端面に対して傾斜した下端面を有する半導体チップ保持部材15に容易に交換することができて、たわみ振動部141に対する半導体チップ保持部材15の取付角度が容易に調整できるとともに、半導体チップ保持部材15が摩耗したときにも、交換が容易である。

【0080】（第7実施形態）本発明の第7実施形態にかかるフリップチップ実装用超音波接合方法を実施することができるフリップチップ実装用超音波接合装置は、たわみ振動部141の下端部での半導体チップ保持部材15の保持構造が第4，5，6実施形態と異なるものである。すなわち、たわみ振動部141の下端部での半導体チップ保持部材15の保持構造が、図21に示すように、上記半導体チップ保持部材15をICチップ6に対して、上下方向と直交する横方向に対して斜め方向に超音波振動を与える超音波ホーン14の上下方向沿いに設けたたわみ振動部141は、接合基板3の接合面に対して垂直な貫通穴1411を設け、その下端部に下向きに広がった20°～40°の屋根型又は円錐型の傾斜面1412を設けている。上記半導体チップ保持部材15に相当する半導体チップ保持部材154は、その中心部に下端面から上向きに中央部まで延びるスリット1543を設けるとともに、下端部の円板状の半導体チップ保持部154aにICチップ6を横方向から保持して横方向に脱落しないようにするためのICチップ6より少し大きめの窪み1541を設けて、窪み1541内にICチップ6を隙間を介して遊嵌可能としている。また、半導体チップ保持部材154の円板状の半導体チップ保持部154aの上部には、上記たわみ振動部141に設けた屋根型又は円錐型の傾斜面1412と大略同じ傾斜角度の傾斜面1542を設け、その上に取付軸部1544を設けて構成されている。上記たわみ振動部141と上記半導体チップ保持部材154は、上記加圧装置11により、加圧力51で示されるように下向きに加圧されると、上記たわみ振動部141の傾斜面1412と上記半導体チップ保持部材154の傾斜面1542が係合して当接し、半導体チップ保持部材154がICチップ6を挟み込むように構成されている。また、上記半導体チップ保持部材154は、その取付軸部1544の中間部の側面に設けた円錐状にへこんだ切欠部1545に、その取付軸部1544の軸方向に垂直に、上記たわみ振動部141に設けたボールプランジャ28の先端のボール28aが押し当てられ、上記半導体チップ保持部材154が上記たわみ振動部141と一体的に上方向に引き上げられるように構成している。

【0081】以下に、上記フリップチップ実装用の超音波接合装置を用いた超音波接合方法を説明する。

【0082】まず、ICチップ6は、半導体チップ保持部材154に吸引用配管24を通じて吸着固定され、認識動作を経て、接合基板3の所定位置に位置決めされる。

【0083】次いで、ICチップ6は、上記フリップチップ実装用超音波接合装置1により、ICチップ6や接合基板3の厚み方向に上記半導体チップ保持部材15を移動させるとともに、ボイスコイルモータ11と接合加圧制御装置16にて動作制御され、ICチップ6と接合基板3との接合のための加圧力51による加圧押し込みが行われる。この加圧力51により、たわみ振動部141の下端部の円錐型の傾斜面1412が、半導体チップ保持部材154の大略同じ傾きの傾斜面1542を加圧力52で下向きに押し込む。図21に示すように、この加圧力52の分力53が横方向に働くことにより、半導体チップ保持部材154に設けられたスリット1543が狭められるように半導体チップ保持部材154の全体が撓み、半導体チップ保持部材154の窪み1541の内面同士が横方向沿いに互いに接近する方向に撓み、窪み1541の内面によりICチップ6を挟み込む。その後、ボイスコイルモータ11の先に取り付けられたブラ

ケット１２に取付けられた超音波ホーン１４の振動子１３に超音波発振器１７より超音波振動信号が送られ、振動子１３から発生した縦振動を超音波ホーン１４が増幅し、更に超音波ホーン１４に上下方向沿いに設けられた上記たわみ振動部１４１に、超音波振動が与えられる。この超音波振動がＩＣチップ６に機械的に伝達され、ＩＣチップ６の各バンプ８と接合基板３の各電極９とが金属接合される。

【００８４】この後、ボイスコイルモータ１１と接合加圧制御装置１６にて動作制御されて加圧押し込みの加圧力５１がゼロとなり、たわみ振動部１４１の先端の円錐型の傾斜面１４１２と、半導体チップ保持部材１５４の傾斜面１５４２との間での加圧力５２もゼロとなり、この加圧力５２の分力５３もゼロとなる。この結果、半導体チップ保持部材１５４の弾性力により、スリット１５４３が元の間隔まで復帰し、半導体チップ保持部材１５４の窪み１５４１の内面がＩＣチップ６の側面から離れ、ボイスコイルモータ１１と接合加圧制御装置１６により、たわみ振動部１４１と半導体チップ保持部材１５４とが一体的に上昇させられて、ＩＣチップ６から離れるように動作制御される。

【００８５】この第７実施形態によれば、半導体チップ保持部材１５４の下端部が、加圧しながらＩＣチップ６を機械的に両側から挟み込みつつ超音波振動を付与するため、ＩＣチップ６が半導体チップ保持部材１５４に対して同じ振動挙動をし、超音波振動が半導体チップ保持部材１５４からＩＣチップ６に安定して伝達される。これにより、ＩＣチップ６と接合基板３との十分な接合強度が得られ、接合信頼性が向上する。また、ＩＣチップ６が半導体チップ保持部材１５４に対して同じ振動挙動をするため、半導体チップ保持部材１５４によるＩＣチップ６へのダメージが無い。

【００８６】なお、本発明は上記実施形態に限定されるものではなく、その他種々の態様で実施できる。

【００８７】例えば、図２２に示すように、例えばＩＣチップ６の材質や厚み又は基板３の材質や厚みなどの接合条件により、超音波ホーン１４の角度θを上記5°～35°の範囲内の任意の値に傾斜角度を調整することができるような傾斜角度調整装置２９を備えるようにしてもよい。この傾斜角度調整装置２９は以下のような構造を有している。

【００８８】すなわち、ブラケット１２に球面状凸部３８を設け、球面状凸部３８に摺動する球面状凹部３７をブラケット１２を支持する支持部材３５に設け、かつ、球面状凸部３８と球面状凹部３７とが常時当接するようにバネ３４で付勢させることにより、球面状凸部３８と球面状凹部３７とで第１球面軸受３６を構成する。また、第１球面軸受３６の球面状凹部３７の表面には第１吸引通路３１に連通する吸引開孔を形成して、第１吸引通路３１により吸引動作させるときには球面状凸部３８と球面状凹部３７とが移動不可に固定される一方、吸引動作を緩めるときには、球面状凸部３８と球面状凹部３７とが相対的に移動可能としている。ブラケット１２の上端部のねじ穴１２ｅには、角度調整ねじ３９をねじ込んでその先端を支持部材３５の側面に当接させている。よって、角度調整ねじ３９を回すことにより、第３吸引通路３３での吸引動作を緩めるときに限り、支持部材３５に対してブラケット１２の上端部が接離する方向に移動可能としている。

【００８９】また、超音波ホーン１４の下端部に球面状凹部１４ｆを形成し、球面状凹部１４ｆに摺動可能な球面状凸部１５ｆを半導体チップ保持部材１５の上部に形成することにより、球面状凸部１５ｆと球面状凹部１４ｆとで第２球面軸受１３４を構成する。また、第２球面軸受１３４の球面状凹部１４ｆの表面には第２吸引通路３２に連通する吸引開孔を形成して、第２吸引通路３２により吸引動作させるときには球面状凸部１５ｆと球面状凹部１４ｆとが移動不可に固定される一方、吸引動作を緩めるときには、球面状凸部１５ｆと球面状凹部１４ｆとが相対的に移動可能としている。また、超音波ホーン１４は、ブラケット１２に対して、先の実施形態に示したような構造で支持又は回転可能に支持されることにより、ブラケット１２に対する超音波ホーン１４の傾斜角度θを調整可能とする。

【００９０】このように構成することにより、第１吸引通路３１での吸引動作における真空圧を大気圧側に緩めたのち、角度調整ねじ３９を回すことにより、支持部材３５に対してブラケット１２の上端部が接近又は離反する方向に移動させて、第１球面軸受３６の球面状凸部３８を球面状凹部３７に対して摺動させて第１球面軸受３６の傾斜角度θを振る。この結果、超音波ホーン１４の傾斜角度θが振られ、第１吸引通路３１での吸引動作における真空圧を上げることで、超音波ホーン１４の傾斜角度θを真空吸着により固定する。

【００９１】次いで、第２吸引通路３２での吸引動作における真空圧を大気圧側に緩めた状態で、加熱ステージ４の上面（基板載置面）に半導体チップ保持部材１５の下端面（ＩＣチップ吸着面）を押し当て、第２球面軸受１３４において第２球面軸受１３４の球面状凸部１５ｆを球面状凹部１４ｆに対して摺動させて、半導体チップ保持部材１５の下端面と加熱ステージ４の上面との平行度を出した状態で、第２吸引通路３２での吸引動作における真空圧を上げ、半導体チップ保持部材１５の下端面と加熱ステージ４の上面とを略平行に保持して真空吸着保持により傾斜角度θを固定する。その後、半導体チップ保持部材１５を移動させて、半導体チップ保持部材１５の下端面でのＩＣチップ６の真空吸着保持は、吸引用配管２４を有する第３吸引通路３３での吸引動作にて行う。

【００９２】このような構成によれば、傾斜角度調整装

置２９により、例えばＩＣチップ６の材質や厚み又は基板３の材質や厚みなどの接合条件により、超音波ホーン１４の傾斜角度θを上記5°～３５°の範囲内の任意の値に傾斜角度を調整することができる。また、ＩＣチップ６の接合状態を見て、超音波ホーン１４の傾斜角度θの微調整を行うことができる。

【００９３】また、本発明は、フリップチップ実装用の超音波接合方法及び超音波接合装置にのみ適用されるのではなく、他の用途にも適用することができる。例えば、ＩＣチップ６などの電子部品にバンプ８を形成するバンプ形成方法及び装置にも適用することができる。一例を図２３に示す。図２３において、加熱ステージ４１上に対象物であるＩＣチップ６を載置する一方、ＸＹテーブル４８に基部の回動支点が取付けられかつキャピラリ駆動部４９により回動支点回りに揺動可能な支持部材４６に、超音波ホーン４２と金線クランパー４３とが支持されている。金線クランパー４３の先端には、金線テンショナー４４から所定の張力を付与しつつ供給される金線４５を保持するキャピラリ４７が配置されている。超音波ホーン４２は、上記各実施形態と同様に、その傾斜角度θを上記5°～３５°の範囲内の任意の値に設定している。

【００９４】このような構成のバンプ形成装置によれば、金線テンショナー４４からキャピラリ４７に供給されてキャピラリ４７の下端から突出した金線４５の下端を放電等により溶融させてボールを形成する。その後、ＸＹテーブル４８により、加熱ステージ４１上のＩＣチップ６に対するキャピラリ４７の位置を直交する２方向であるＸＹ方向に位置決めする。その後、キャピラリ駆動部４９により、回動支点回りに超音波ホーン４２と金線クランパー４３とを揺動させて、形成されたボールをキャピラリ４７を介して加熱ステージ４１上のＩＣチップ６に押し付けて超音波ホーン４２から超音波振動を付与して、ＩＣチップ６のパッド上にバンプ８を形成する。

【００９５】このようにＩＣチップ６のパッド上にバンプ８を形成する場合にも、超音波ホーン４２は、その傾斜角度θを上記5°～３５°の範囲内の任意の値に設定することにより、言い換えれば、ＩＣチップ６に対してバンプ８を上下方向と直交する横方向に対して斜め方向（5°～３５°方向）から超音波振動を与えることでバンプ形成するようにしている。よって、キャピラリ４７に保持された金線４５が超音波ホーン４２に対して同じ振動挙動をし、超音波振動が安定して金線４５に伝達され、金線４５により形成されるバンプ８とＩＣチップ６との十分な接合強度が得られ、接合品質を向上させることができる。また、金線４５により形成されるバンプ８が超音波ホーン４２に対して同じ振動挙動をするため、超音波ホーン４２によるＩＣチップ６へのダメージが無く、商品イメージも向上させることができる。

【００９６】なお、上記様々な実施形態のうちの任意の実施形態を適宜組み合わせることにより、それぞれの有する効果を奏するようにすることができる。

【００９７】

【発明の効果】以上、詳述したように、本発明のフリップチップ実装用の超音波接合方法及び超音波接合装置によれば、接合基板に対して半導体チップを上記半導体チップの上記接合面沿いの横方向に対して斜め方向（5°～３５°方向）から超音波振動を与えることで接合するようにしている。よって、半導体チップが半導体チップ保持部材に対し同じ振動挙動をし、超音波振動が安定して半導体チップに伝達され、半導体チップと接合基板との十分な接合強度が得られ、接合品質を向上させることができる。また、半導体チップが半導体チップ保持部材に対し同じ振動挙動をするため、半導体チップ保持部材による半導体チップへのダメージが無く、商品イメージも向上させることができる。

【００９８】また、本発明のフリップチップ実装用の超音波接合方法及び超音波接合装置においては、半導体チップを基板上にフリップチップ実装するプロセスにおいて、半導体チップにバンプを形成し、基板との位置合わせした後、加圧しながら半導体チップに対して上記半導体チップの上記接合面沿いの横方向に対して斜め方向（5°～３５°方向）に超音波振動を与えて接合するようにすれば、半導体チップ保持部材の先端が、加圧しながら半導体チップに対して上記半導体チップの上記接合面沿いの横方向に対して斜め方向（5°～３５°方向）に超音波振動するため、半導体チップが半導体チップ保持部材に対し同じ振動挙動をし、超音波振動が安定して半導体チップに伝達される。これにより、半導体チップと接合基板との十分な接合強度が得られ、接合信頼性が向上する。また、半導体チップが半導体チップ保持部材に対し同じ振動挙動をするため、半導体チップ保持部材による半導体チップへのダメージが無い。

【００９９】本発明のフリップチップ実装用の超音波接合装置においては、ボイスコイルモータによる加圧力が大きくなっても、超音波ホーンがよ下方向に傾くことなく、半導体チップ保持部材の先端面と接合基板の接合面との間の平行度が保たれる。また、超音波ホーンの節に歪みが発生しても、超音波ホーンの共振状態が崩れることなく半導体チップに対する振動振幅が安定する。これにより、半導体チップと接合基板との十分な接合強度が得られ、接合信頼性が向上する。

【０１００】また、本発明のフリップチップ実装用の超音波接合装置においては、超音波ホーンの縦振動部先端に、上下方向沿いにたわみ振動部を一体型で設ける為、超音波振動状態が安定し、半導体チップの振動振幅が安定する。これにより、半導体チップと接含基板との十分な接合強度が得られ、接合信頼性が向上する。

【０１０１】また、本発明のフリップチップ実装用の超

音波接合装置においては、半導体チップ保持部材の先端が、機械的に半導体チップを挟み込み超音波振動するため、半導体チップが半導体チップ保持部材に対し滑ることなく、超音波振動が安定して半導体チップに伝達される。これにより、半導体チップと接合基板との十分な接合強度が得られ、接合信頼性が向上する。また、半導体チップが半導体チップ保持部材に対し同じ振動挙動をするため、半導体チップ保持部材による半導体チップへのダメージが無い。

【図面の簡単な説明】

【図１】　（Ａ），（Ｂ）はそれぞれ本発明の第１実施形態のフリップチップ実装用の超音波接合方法の工程を示す説明図である。

【図２】　上記第１実施形態のフリップチップ実装用の超音波接合装置の正面図である。

【図３】　上記フリップチップ実装用の超音波接合装置の半導体チップ保持部材の保持構造を示す正面図である。

【図４】　（Ａ），（Ｂ）はそれぞれ上記フリップチップ実装用の超音波接合装置の超音波ホーンの取付け構造を示す正面図である。

【図５】　上記第１実施形態のフリップチップ実装用の超音波接合方法と従来の超音波接合方法との比較において、ＩＣチップ内のバンプの個数と接合不良の割合との関係を示す図である。

【図６】　上記第１実施形態のフリップチップ実装用の超音波接合方法において、超音波振動が上下方向すなわちＺ方向の成分を有することを示す説明図である。

【図７】　上記第１実施形態と従来のフリップチップ実装用の超音波接合方法との比較における接合時間の比較を示す説明図である。

【図８】　上記第１実施形態と従来のフリップチップ実装用の超音波接合装置の上記半導体チップ保持部材のコレットとＩＣチップとの関係を示す説明図である。

【図９】　上記第１実施形態のフリップチップ実装用の超音波接合方法における超音波振動と上下方向の加圧力との関係を示す説明図である。

【図１０】　上記第１実施形態のフリップチップ実装用の超音波接合方法における超音波振動と上下方向の加圧力との関係を示すグラフである。

【図１１】　本発明の第１実施形態のフリップチップ実装用の超音波接合装置の斜視図である。

【図１２】　図１１のフリップチップ実装用の超音波接合装置の超音波接合ヘッド部の斜視図である。

【図１３】　本発明の第２実施形態の半導体チップ保持部材の保持構造を示す正面図である。

【図１４】　本発明の第３実施形態の半導体チップ保持部材の保持構造を示す正面図である。

【図１５】　本発明の第４実施形態のフリップチップ実装用の超音波接合装置の正面図である。

【図１６】　（Ａ），（Ｂ），（Ｃ）はそれぞれ上記第４実施形態のフリップチップ実装用の超音波接合装置の半導体チップ保持部材の保持構造を示す左側断面図（図１６（Ｂ）でのＸ－Ｘ線断面図）、正面図、及び、底面図である。

【図１７】　本発明の第５実施形態のフリップチップ実装用の超音波接合装置の正面図である。

【図１８】　（Ａ），（Ｂ）はそれぞれ上記第５実施形態のフリップチップ実装用の超音波接合装置の超音波ホーンの平面図と正面図である

【図１９】　（Ａ），（Ｂ）はそれぞれ上記第５実施形態のフリップチップ実装用の超音波接合装置の超音波ホーン取付け部の平面図と正面図である。

【図２０】　（Ａ），（Ｂ），（Ｃ）はそれぞれ本発明の第６実施形態のフリップチップ実装用の超音波接合装置の半導体チップ保持部材の保持構造を示す左側断面図（図２０（Ｂ）でのＸ－Ｘ線断面図）、正面図、及び、底面図である。

【図２１】　本発明の第７実施形態のフリップチップ実装用の超音波接合装置の半導体チップ保持部材の保持構造を示す一部断面正面図である。

【図２２】　本発明の他の実施形態のフリップチップ実装用の超音波接合装置の超音波ホーンの傾斜角度を調整可能な傾斜角度調整装置を有する超音波接合装置の正面図である。

【図２３】　本発明をバンプ形成方法及び装置に適用した例を示すバンプ形成装置の正面図である。

【図２４】　従来のフリップチップ超音波接合設備の斜視図である。

【図２５】　従来のフリップチップ超音波接合ヘッド部の斜視図である。

【図２６】　従来のフリップチップ超音波ホーンの正面図である。

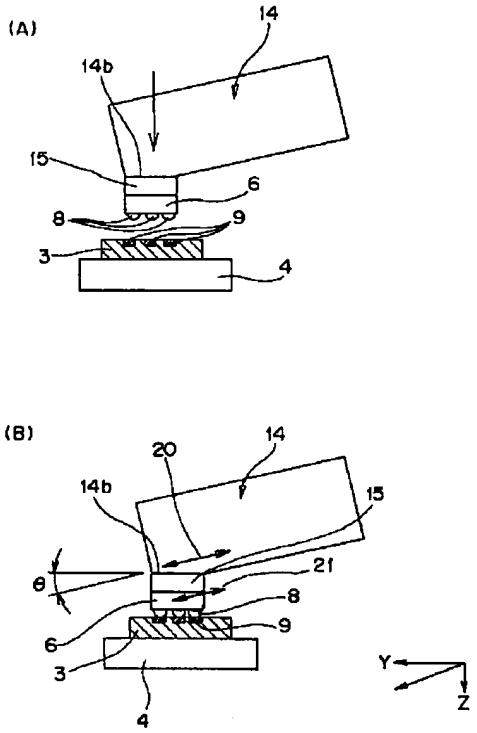
【図２７】　（Ａ），（Ｂ）はそれぞれ従来のフリップチップ超音波ホーンにより接合されたＩＣチップと基板との接合状態を示す部分平面図及び側面図である。

【符号の説明】

１…フリップチップ実装用超音波接合装置、１Ａ…ＩＣチップ取出装置、２Ａ…基板搬送装置、２Ｂ…基板搬送装置、３…基板、４…加熱ステージ、５…ウエハーシート、６…ＩＣチップ、６ａ…パッド、７…加熱制御装置、８…バンプ、９…電極、１０…電子部品、１１…ボイスコイルモータ、１１ａ…駆動軸、１１１…加圧力、１２…ブラケット、１２ａ…取付板、１２ｅ…ねじ穴、１３…超音波振動子、１４…超音波ホーン、１４ａ…取付けフランジ、１４ｂ…下端面、１４ｃ…貫通穴、１４ｄ…ねじ穴、１４ｅ…ねじ穴、１４ｆ…球面状凹部、１４１…たわみ振動部、１４１ａ…吸引通路、１４１ｂ…貫通穴、１４１ｅ…ねじ穴、１４１１…貫通穴、１４１２…傾斜面、１４２，１４３…リブ、１４４，１４５…

取付部、１４３１…リブ、１４３２…第１折り曲げ部、１４３３…第２折り曲げ部、１４６…割締め穴部、１４６ａ…ねじ穴、１５…半導体チップ保持部材、１５ａ…コレット、１５ｂ…吸引孔、１５ｆ…球面状凸部、１５１０…取付軸部、１５１１…ねじ、１５２…取付軸部、１５３…取付軸部、１５３１…ねじ、１５４…半導体チップ保持部材、１５４ａ…半導体チップ保持部、１５４１…窪み、１５４２…傾斜面、１５４３…スリット、１５４４…取付軸部、１５４５…切欠部、１６…接合加圧制御装置、１７…超音波発振器、２０…超音波ホーンの超音波振動方向、２１…ＩＣチップの超音波振動方向、２４…吸引用配管、２５…ボルト、２５１…ナット、２６…取付ボルト、２７…取付ボルト、２８…ボールプランジャ、２８ａ…ボール、２９…傾斜角度調整装置、３０…フリップチップ実装装置、３１…第１吸引通路、３２…第２吸引通路、３３…第３吸引通路、１３４…バネ、３５…支持部材、３６…第１球面軸受、３７…球面状凹部、３８…球面状凸部、３９…角度調整ねじ、４１…加熱ステージ、４２…超音波ホーン、４３…金線クランパー、４４…金線テンショナー、４５…金線、４６…支持部材、４７…キャピラリ、４８…ＸＹテーブル、４９…キャピラリ駆動部、５１，５２…加圧力、５３…分力、１３４…第２球面軸受。

【図１】



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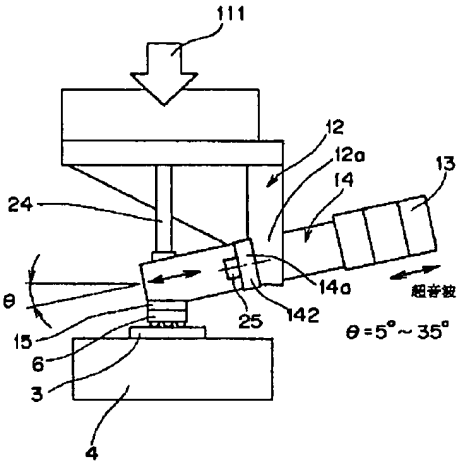

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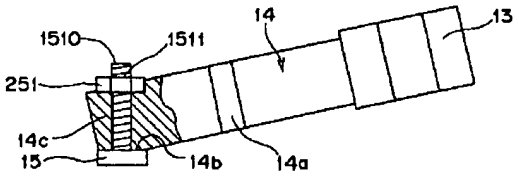

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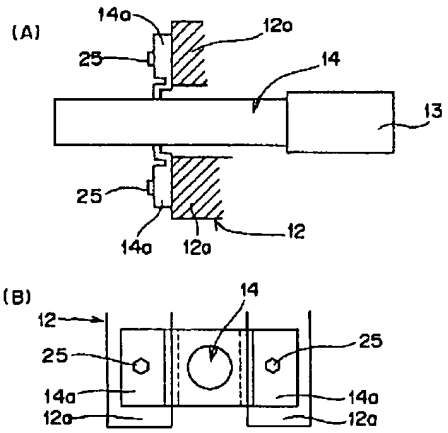

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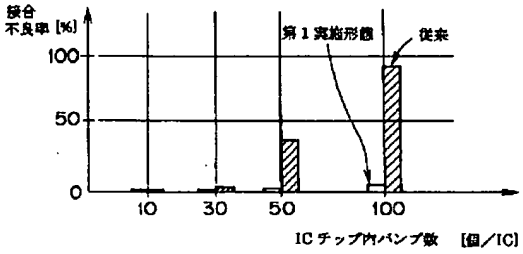

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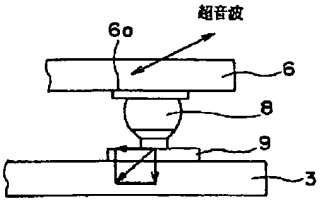

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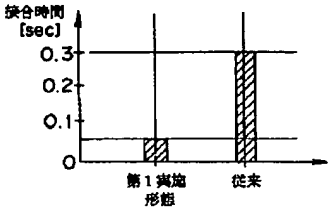

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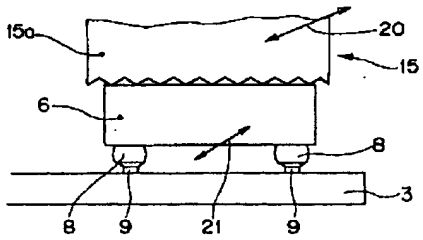

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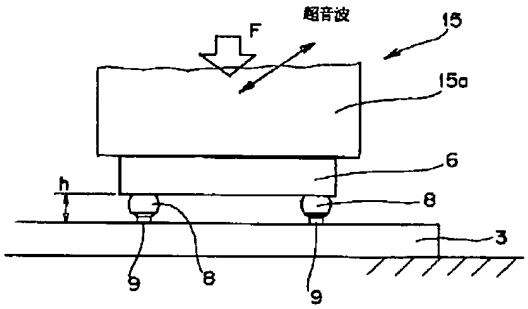

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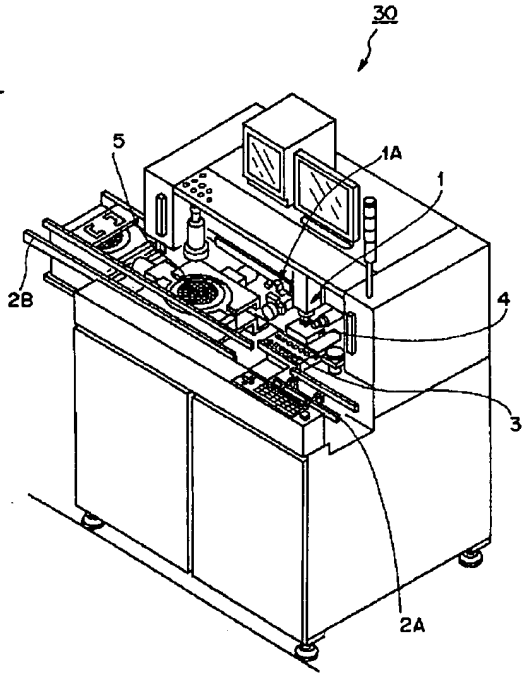

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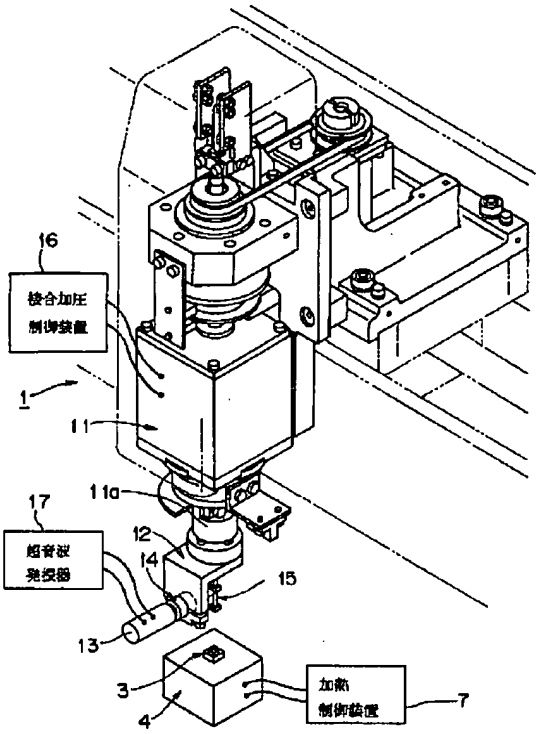

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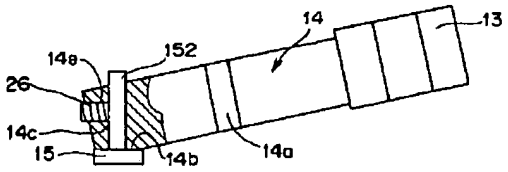

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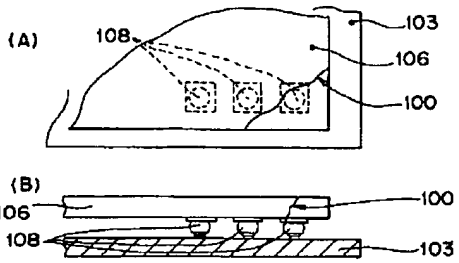

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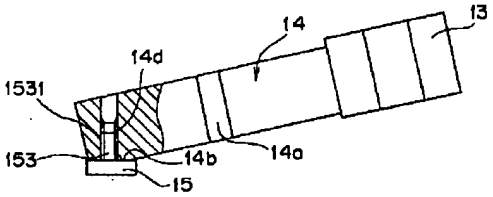

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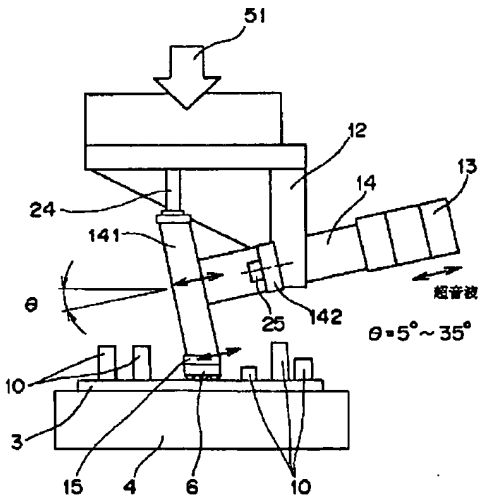

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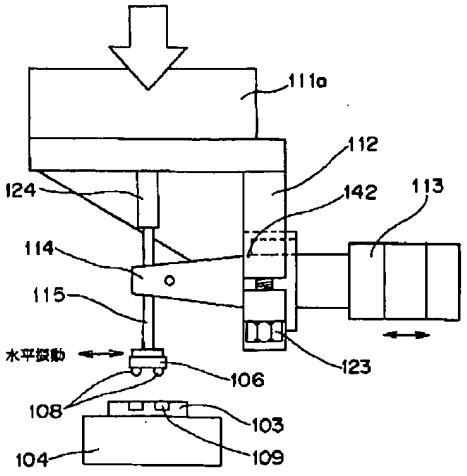

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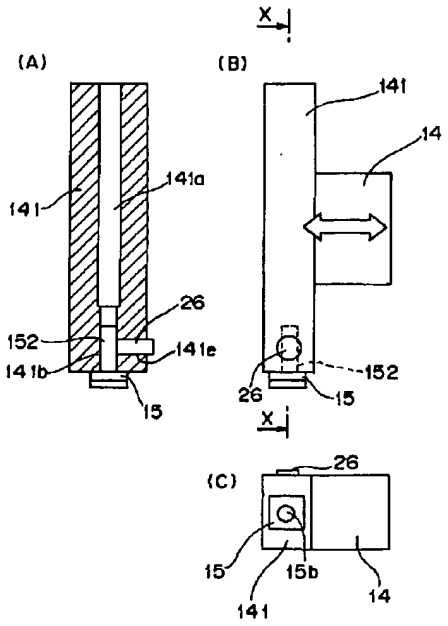

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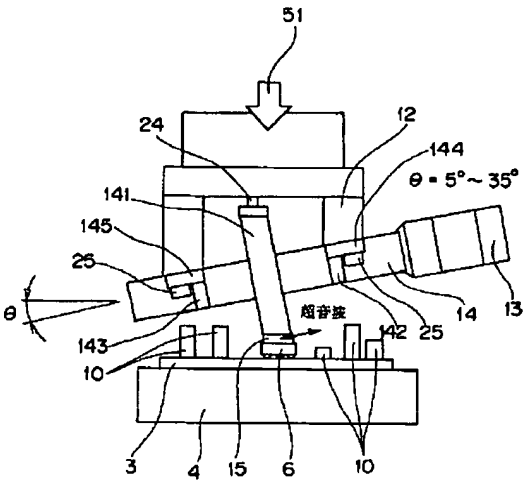

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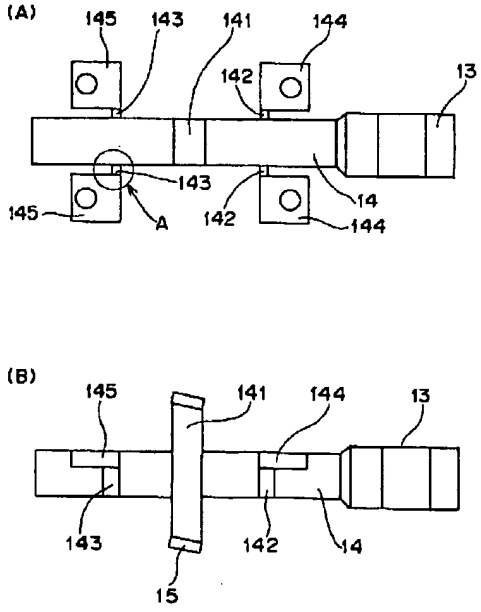

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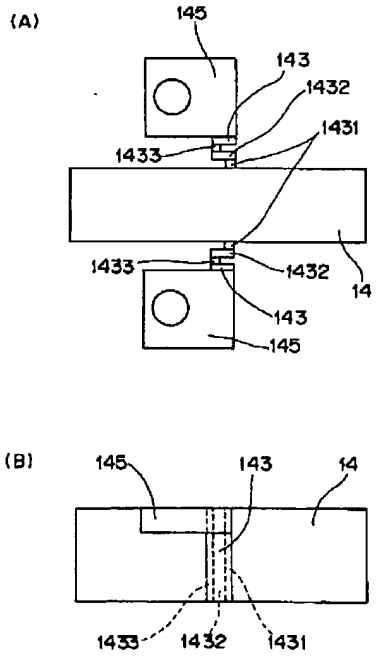

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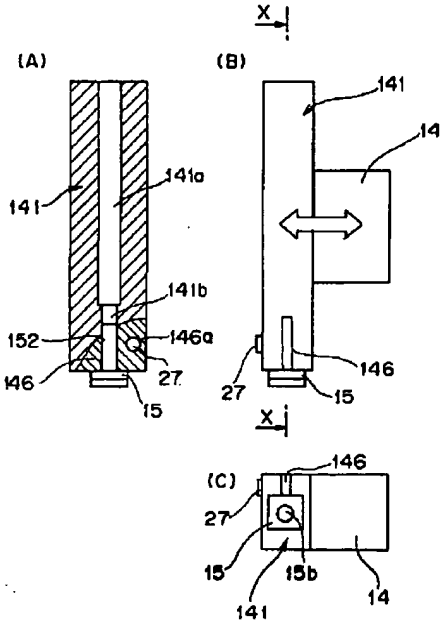

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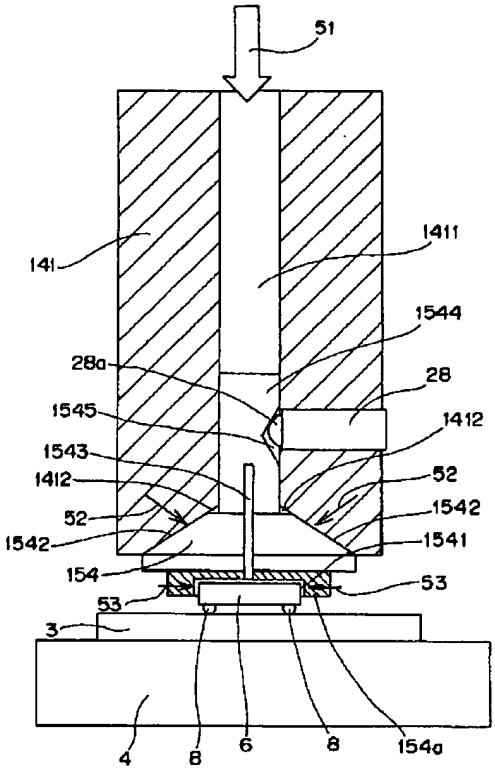

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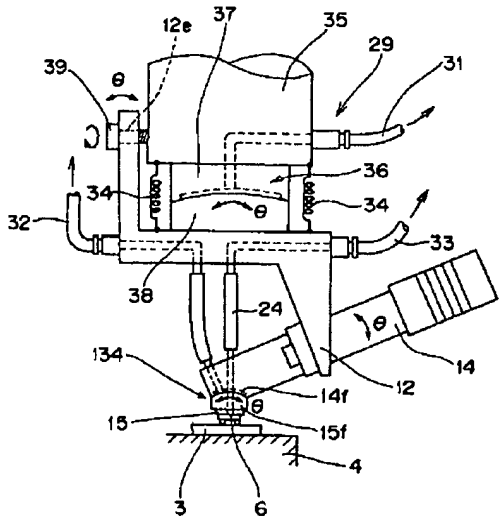

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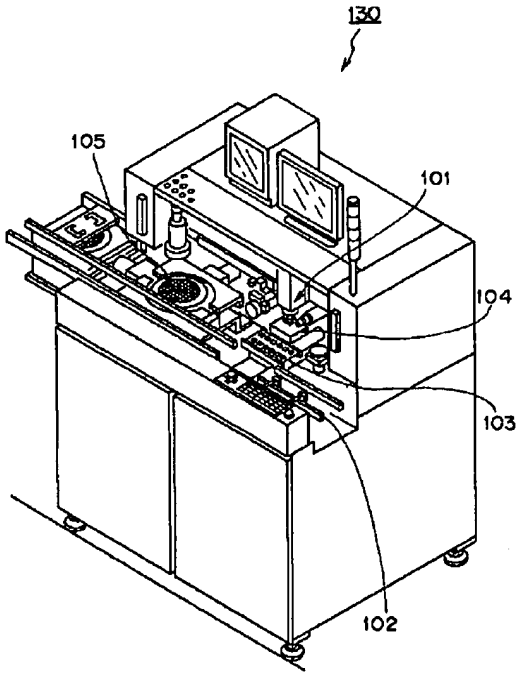

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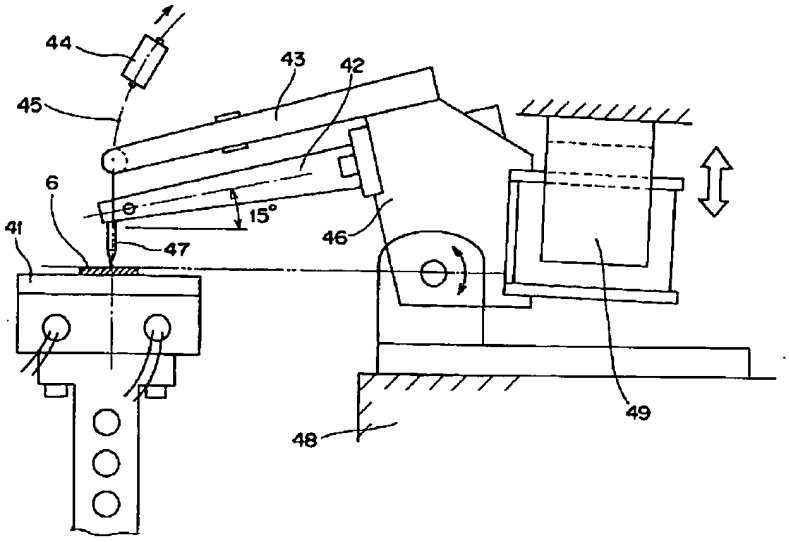
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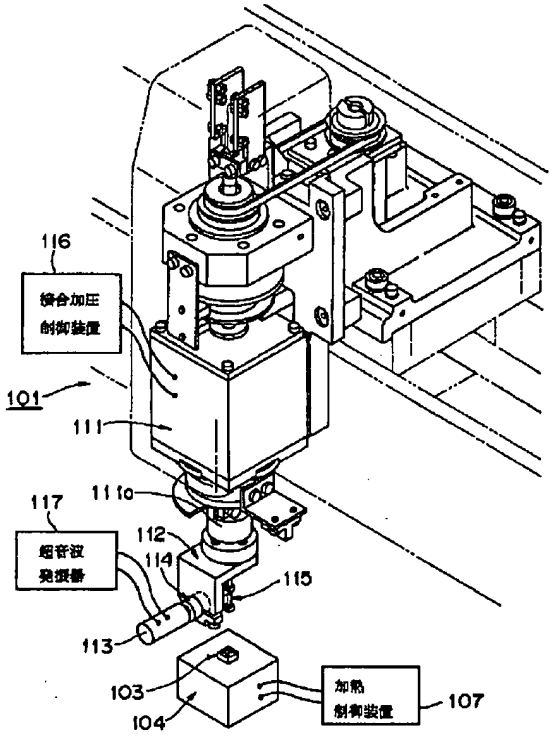
43
42
45
6
15°
41
47
46
49
48

【図25】


116
接合加圧
制御装置
101
111
110
117
超音波
発振器
112
114
115
113
103
104
加熱
制御装置
107

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